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THE

EDINBURGH ANNUAL REGISTER,

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THE Proprietors of the EDINBURGH ANNUAL REGISTER having redeemed their pledge, of bringing down that work to the regular period of publication, feel themselves justified in soliciting attention to some observations on the nature of the work itself, and the shape in which it is now presented before the public.

Ever since the general diffusion of knowledge, through the medium of the press, a work such as an Annual Register has been considered indispensable to the literature of a country. It becomes necessary, in order to rescue the events of the year from that confusion and oblivion which soon involves them, even in the eyes of those who have attended most closely to their daily lapse,—to form them into a combined and connected series, and exhibit them in that consistency and visible relation to each other, which time only can give. It is for the Annalist to rise above the little passions and interests of the moment, to contemplate events in their high historical bearings, to connect them with past and with future ages. Such a volume forms, also, a convenient depository for many important public documents, which, combined with the narrative, may render it a valuable storehouse of materials for the future historian. Again, beneath the high interests of the political scene, various minor particulars, standing out from the canvas of private life, may be selected from perishable materials, to form interesting objects of contemplation.

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In the Literary Department, as well as in that variety of minor and

miscellaneous objects which come under the head of Chronicle, the Compilers have adopted a plan, which they conceive they may fairly consider as original. Instead of strings of unconnected paragraphs, common-place essays, and long extracts from books, they have studied to make their work exhibit a complete picture of the period to which it refers. Rejecting all extraneous and irrelevant matter, they present, in an arranged and connected view, every thing most interesting, which the year has presented, in every department of human pursuit. An important Chapter is devoted to the record of Scientific Discoveries and Improvements. These are exhibited, of course, rather in their grand outline, than in their minute details; with a view rather to estimate the general progress of human knowledge and thought, than the merits of particular writings and discourses. Biographical Notices, as satisfactory as possible, are given of all eminent persons deceased within the year. A view is given of all Geographical Discoveries made within the period, with abstracts and notices of interesting Voyages and Travels. A copious collection of State Papers, Diplomatic Correspondence and Parliamentary Reports, is embodied in the work. The most important and curious Trials and Law Proceedings are very fully reported. A selection is made of Fugitive and Occasional Poetry, which has appeared in the course of the year. Articles of intelligence relating to Literature,—to the Arts,—to Ecclesiastical Affairs, and Religious Societies,—to Commerce,—to Agriculture,—to National and Local Improvements, are collected and arranged under their appropriate heads. A General Chronicle is then reserved for the reception of all those minor and miscellaneous notices, not referable to any special head, yet which contain information and interest, and without which "the very age and body of the time" could not be exhibited. The volume is closed with a number of useful Lists for record and reference.

The only heavy complaint which has been lodged against the Edinburgh Annual Register, and which has even been represented as cancelling all its other merits, is founded on the extreme delays which have retarded its publication. On these delays, and their unavoidable causes, the Proprietors need say very little, since they now produce the volume at the very earliest period when it could possibly appear. They hope also, from the time at which the composition was begun, the diligence employed, and the prompt transmission of foreign

materials, that though imperfections must exist, there will not, on the whole, appear marks of premature production.

The Edinburgh Annual Register has now been carried on for SEVENTEEN years, and consequently embraces a period in the history of Europe and of the world, which has not been surpassed, perhaps not equalled in interest, by any similar portion of time. Not only has it been marked by public events of unexampled magnitude, but this country, and in some measure all the countries of Europe, have been making most rapid advances in all the arts that dignify and adorn life; in literature and science; in their public establishments; and in the security and perfection of their domestic enjoyments.

It is obviously impossible, in a notice of this kind, to give even an outline of the multitude of important subjects which a work of such extent and such various materials must necessarily embrace. The following can only be considered as a very imperfect abstract.

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View of the Changes proposed and adopted in the Administration of Justice in Scotland. Some Account of an Attempt made by M. Balmar, a Hanoverian, and M. Francis Huger, an American, to liberate M. de la Fayette from his confinement in the Castle of Olmutz, 1794. Cursory Remarks upon the French Order of Battle, particularly in the Campaigns of Bonaparte. Account of the Bell-Rock Light-House. Account of an Ancient Wooden Coffin discovered in Parish of Culsalmond, Aberdeenshire. History of Lope de Aguirre. Journal of a Levant Pirate. Scotticisms. Review of the Arguments on the Corn Laws. Account of the Campaigns of Montrose, translated from the Gaelic Language. Extracts from a Journal kept during a coasting Voyage through the Scottish Islands. Reflections on the Introduction of Trial by Jury, in Civil Causes, into Scotland. Two Historical Pieces connected with the American War of Independence, viz. 1. Conspiracy of Arnold and Sir Henry Clinton against the United States, and against General Washington; translated from the French of Count Berbé Marbois. 2. Conspiracy of Arnold, 1780. An Account of the Operations of the French Army, in the United States of America, during the War of Independence; translated from the French of the Memoirs of Marshal Count de Rochambeau. Account of a Pedestrian Excursion from Geneva to the Valley of Chamounix, and of a Visit to the Higher Regions of Mer de Glace.

STATE PAPERS, CHRONICLE, &c.

Beside the subjects arranged under the preceding titles, the Register is enriched with a great and most valuable mass of *State Papers*, illustrative of the different parts of the General History, and affording excellent materials for those who wish to pursue that History into its more secret causes. In furnishing these, care has been taken, by comparing the translations with the originals, to present Foreign Documents in a more correct state, than that in which they are usually offered to the British Public.

The second part of each volume also contains a copious *Chronicle* of Remarkable Events, including such incidents as either form no part of the General History, or are only slightly touched upon in the narrative of great Public Events. Such a Chronicle is evidently indispensable in a Work proposing to afford a complete view of the events of any year, and this record accordingly occupies

a considerable portion of the second part of each volume. Of *the State Papers*, however, and of the *Chronicle*, it is obviously impossible to present any abridgment in an analysis of this kind.

TRIALS AND LAW PROCEEDINGS.

1. State Trials.

Among those the following may be selected as specimens:—Cashman, Hooper and others. James Watson the elder. Jeremiah Brandreth. Alexander Maclaren and Thomas Baird. Niel Douglas. Andrew Mackinlay. J. Johnson. S. Drummond and J. Bagueley. Thistlewood and his Companions. Hunt and nine others for their concern in the proceedings at Manchester. Sir Francis Burdett for Libel. Sir Charles Wolseley, Bart. and Joseph Harrison, for Sedition. Cartwright, Wooler and others. Scottish Insurgents at Bonnymuir. William Wilson, for High Treason. Robert Monroe. John Spiers. Thomas Mackay. Judgment on Sir Francis Burdett. Cartwright. Wooler, &c. O'-Brien for conspiring to excite Disaffection.

Evidence on the Bill of Pains and Penalties against the Queen. 1. Evidence for the Prosecution. 2. Evidence for the Defence.

2. Trials for Libel.

Thomas Jonathan Wooler. James Williams. William Hone. Clement. J. Edward Taylor. Richard Carlisle. Davidson for Libel, in the Republican, and Deists' Magazine. Cobbett for Libel on Cleary. Cobbett for Libel on Wright. Thomas Flindell for a Libel on the Queen. Rev. Richard Blacow for Do. Mary Anne Carlyle for Blasphemous and Seditious Libels. John Hunt for Libel on the House of Commons. Dolby at the instance of the Constitutional Association. John Bull for Libel on Lady Caroline Wrottesley. Weaver and others. Duncan Stevenson, Printer of the Beacon. William Blackwood. John Ambrose Williams. Capt. Nicolas Bull for Libel on Fyshe Palmer, Esq. Harvey and Chapman for imputing Insanity to the King, &c.

3. Criminal Trials.

The Luddites at Leicester. Roger O'Connor. The Ashcrofts. Thistlewood. Lieut. David Davis. Jacob Heischcliffe and Joseph Baker. Joseph Smith and William Philips. Estoff. Charles Hussey. Palmer, C. Hope, &c. Joseph Robertson. Potts, Wood, &c. Augustine, Bogle, French and others. Maria Walton. John Drake, Alexander Dewar, and Christopher Bustead. Thomas Osborne. Robert Turner Watkins and Edward Watkins. George Warden. Quia Pei, a captured Negro, for Murder. Nesbitt for the Murder of Mr Parker and his Housekeeper. Trial of Soldiers for Murder, by firing from a Window at Greenock. Murderers of Mrs Torrance. Michael Moran, &c. for Murder of Thomas Manning. Timothy Shea for various Offences. Messrs Christie and Trail for Duel with Mr Scott. Manasseh Gouldstein for forging Prussian Dollar Notes. James Stuart, Esq. younger of Dunearn. James Forbes and the Rioters at the Dublin Theatre. Mrs M'Kinnon for the Murder of William Howatt. Andrew Riding for Attempt to assassinate Sam. Horrocks, Esq. Inquest on the Murder of Weare. Trial of Dr Castaing at Paris for Murder. John Pallett for Murder, &c.

4. Prosecutions and Miscellaneous Cases.

Mr Southey for Suppression of Wat Tyler. Sir M. R. Burgoyne for Non-Attendance at Public Worship. Mr Scarlett for Defamation at the Bar. Proceedings in Chancery relative to the Marriage of Lord Stewart to Lady Frances Vane Tempest. The Duke of Marlborough for cutting down the Woods, and otherwise injuring the Estate of Blenheim. Proceedings against the Magistrates

of Edinburgh, relative to the Erection of Buildings on the North Bridge. Deacon Lawrie and others against the Magistrates of Edinburgh. Proceedings in Chancery relative to the shutting of Drury-Lane Theatre. John Elmore for Malicious Arrest. Jones for Gambling. Pettigrew for Unskilfulness as a Surgeon. Sir Manasseh Masseh Lopez, Bart. for Bribery and Corruption. Pleas of Insurance Offices relative to Chemical Apparatus employed by Severn, King and Co. Mackoull against the Paisley Union Company. Legality of the Marriage between the Marquis and Marchioness of Donegal. Lord Erskine and Lady Erskine. Mr Elliston for Representation of Marino Faliero. Murray against Rundell, for Copyright of "Domestic Cookery." Benbow and Hees for publishing Lord Byron's "Cain." Smith for Lawrence's Lectures. Commission of Lunacy on Lord Portsmouth, and on Sir Gregory Page Turner. The Deccan Prize Cause, &c.

PROCEEDINGS OF PUBLIC SOCIETIES.

Royal Society of London. Do. of Edinburgh. Asiatic Society. Madras Literary Society. Linnean Society. Wernerian Society. National Society for educating the Poor. Hibernian Society. Highland Society of Scotland. Caledonian Horticultural Society. Society for Encouragement of Arts, Manufactures, and Commerce. African Society. Hibernian Society in London for establishing Schools, and circulating the Scriptures in Ireland. Association for Relief of Distressed Seamen in the City of London. Edinburgh Institution for Deaf and Dumb Children. Royal Institute of France. Geological Society, &c.

REPORTS ON THE DIFFERENT BRANCHES OF PUBLIC ECONOMY.

Agricultural. Commercial. Medical. Ecclesiastical. On Public Worship, and Local Improvements. Emigration. The Fine Arts. Prices of Shares in Canals, Docks, Bridges, Roads, Water Works, Fire and Life Insurance Companies, Gas Light Companies, Institutions, &c.

LISTS.

New Publications. Births, Marriages, and Deaths.

POETRY.

Each Volume of the Register is enriched with a copious selection of Poetical Pieces, many of which are of the highest merit, and all of them by Authors of the highest talents. In the list of contributors to this department are found the names of Sir Walter Scott—Southey—Wordsworth—Coleridge—Byron—Wilson—Johanna Baillie—Leyden—Mrs Hemans—Thomas Campbell—John Finlay—James Hogg. To the Pieces furnished by these Authors, either directly or by permission, is added a multitude of occasional and popular verses by Authors of inferior name, but all capable of adding something worth preserving to his beautiful department of National Literature.

TRANSACTIONS

OF THE

HIGHLAND SOCIETY

OF

SCOTLAND.

PRIZE-ESSAYS

AND

TRANSACTIONS

OF THE

HIGHLAND SOCIETY

OF

SCOTLAND.

TO WHICH IS PREFIXED,

AN ACCOUNT OF THE PRINCIPAL PROCEEDINGS OF THE SOCIETY FROM NOVEMBER 1820 TO DECEMBER 1823.

VOL. VI.

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INTRODUCTION.

ACCOUNT OF THE PRINCIPAL PROCEEDINGS OF THE HIGHLAND SOCIETY OF SCOTLAND, SINCE NOVEMBER 1820.

THE Introduction to the first volume of "Transactions of the Highland Society of Scotland," embraces a general view of its Proceedings from the institution of the Society to the year 1799. Each of the following volumes, in like manner, contains introductory notices applicable to the periods intervening between the date of its publication and that of the volume immediately preceding. The fifth volume having been published in November 1820, the introduction to the present volume will therefore include a brief detail of some of the principal proceedings of the Society during the last three years.

The Society's rewards are chiefly intended to encourage actual improvements on the part of the Te-

nantry throughout Scotland; and, being usually distributed in pecuniary premiums, will be best explained by a reference to the List of Premiums offered and awarded, as annually advertised. It may be sufficient, therefore, in this place merely to observe, that the Society's premiums have been extended in variety, and amount, in a ratio corresponding to the continued and increasing support which it has hitherto been so successful in obtaining from the public.

It was noticed in the introduction to the first volume, in 1799, that the pecuniary rewards then offered had advanced to L. 250 per annum; and although, as observed in the last volume, the Society does not now receive any grant of public money, yet, from the increasing accession of members, the prudent administration of the funds, and the economical system on which the Society's business is conducted, the Directors have been enabled, during the last three years, to offer, in the annual List of Premiums, rewards to the amount of about L. 1400 Sterling, for promoting Agricultural and other improvements in Scotland.

AGRICULTURE AND RURAL ECONOMY.

In the third volume of these Transactions, which was published in 1807, it is remarked, that the Society, although originally instituted more particularly to encourage Improvements in the Highlands, had even then found it practicable to extend its exer-

tions to all parts of Scotland, and had thus gradually become the General Agricultural Society of this part of the United Kingdom. This character it now enjoys; and, whilst it still continues to devote a great share of its attention to promote the prosperity of the Highlands, where agriculture is less advanced, and the stimulus of rewards consequently more requisite, the Premiums are, with a most impartial hand, distributed all over Scotland.

1. *Green Crops.*

In many remote districts of the country, where the improved system of modern Husbandry is either entirely unknown, or only in its infancy, the injury occasioned by a deficiency in the supply of food for the support of live-stock during winter, has been often severely felt. During the period under review, premiums for raising turnips and potatoes in drill, with clover, rye-grass, and other grasses, have been given in Orkney and Shetland, and in several islands and remote districts of the counties of Argyll, Inverness, Ross, and Cromarty, which, it is very gratifying to the Society to find, have been attended with the best results. In Orkney and Shetland, where turnip and clover crops were almost unknown, they are now very generally raised after the drill system, even by the small tenantry, and with great success.

Under the head of Green Crops, may be noticed the premiums which have now been offered for *saving clover-seed* in Scotland. Some samples of seed saved, were transmitted to the Society, which were apparently equal to the best Dutch clover; and it seemed obvious, that, in several districts, and in favourable seasons, the seed of this most useful plant may be brought to maturity in Scotland, if the attention of enterprising farmers were called to it. With this view, premiums have been offered, and the result of any experiments made in consequence will be reported in 1824.

2. *Drill Husbandry.*

The last volume contained the result of some experiments in cultivating grain crops in drill. The Society has continued to encourage the farther extension of this system in those districts more particularly adapted to it; and the result of an experiment in Morayshire, by Mr Lawson at Old Mills, who obtained the first premium of twenty guineas, will be found among the papers in this volume. A premium for the most extensive set of experiments as to the comparative advantages of the broadcast and drill systems of cultivating grain crops, will be decided in 1824.

3. *Raising Grain of the greatest Weight.*

Premiums for raising Barley and Bear or Big of the greatest weight, have been awarded in several districts.

4. *Dairy Husbandry.*

As it appeared to the Society, that sufficient attention had not been paid in many parts of Scotland, to the improvement and management of the Dairy, premiums for encouraging that important object, have been offered and awarded in 1821 and 1822, in the counties of Linlithgow, Dunbarton and Renfrew. They are now offered in the counties of Berwick, Roxburgh, Selkirk and Peebles, and will afterwards be extended in rotation to such other districts as are adapted to this branch of husbandry. An abstract of the reports made by the successful competitors, in so far as the premiums have already been decided, will be found in this volume; and although those reports may appear defective, in what regards the outlay and expence of management, the result seems to shew, that the dairy husbandry has yielded a better return to the competitors, during the last two years, than, in their situation, they could have realised by any other system of management.

5. *Draining.*

1. *Draining Moss or Bog Land.*—It is well

known that a great extent of surface in the hilly districts of Scotland consists of moss. Its origin, nature, and properties have been the subject of much discussion, and a great deal of useful information, scientific and practical, has of late years been given to the public, in regard to its improvement. The Society, from its first institution, has bestowed much pains and expence in procuring information by essays, on the means of reclaiming moss, and in pecuniary rewards for carrying the suggestions in these essays practically into effect. In consequence of these measures, and of the enterprising spirit of our landowners and tenantry, large portions of this description of land have accordingly been, and still continue to be, reclaimed. There is, however, a certain kind, known by the name of *flow-moss*, which is less susceptible of amelioration. Tracts of it, from their situation, and the superabundance of moisture absorbed and constantly retained, having apparently a very prejudicial effect on the climate, the Society, in 1821, offered liberal premiums to proprietors and tenants, to encourage the drainage of flow-moss and bog-land. The conditions required that the extent of drainage executed should not be under 500 roods,—that the ground should be effectually cleared of stagnant water, and superabundant moisture,—and, in so far as circumstances would admit, rendered fit for being planted with trees, carrying grain, or producing useful herbage for the pasturage of cattle and sheep. A district comprehend-

ing certain parishes in the counties of Lanark, Linlithgow and Stirling, was selected for the premiums in the first instance, and the result of the competition was so satisfactory, that the Society has continued the premiums, to encourage farther improvements, for other two years in the same parishes, where much remained to be done, before transferring them to another district.

A general view of the first experiments is given among the papers in this volume. There will also be found a very interesting Report of the Drainage of a small Lake within the same district, by Patrick Wishart, Esq. of Lochcoat, for which an honorary medal was voted by the Society.

2. *Surface or Sheep Drains.*—The Society continues to offer Premiums for encouraging the improvement of mountain pastures by means of Surface or Sheep drains, which being made at comparatively very small expence, are found to produce the best effects on the quality of the pasture and the health of the stock. Since the publication of last volume, these premiums have been given in the pastoral districts of Lanarkshire, Argyleshire, and Perthshire.

3. *Wedge-Draining in Clay or Carse Soils.*—The Society has offered premiums for promoting the extension of Wedge-Draining in clay or carse lands, a process which had previously been found to be attended with very beneficial effects in this

description of soil. A communication from Mr Moir of Leckie, in a letter to Mr Home Drummond, M. P. one of the Directors, with relative descriptions and engravings of the tools employed, are given in this volume.

6. *Experiments with Salt as a Manure, &c.*

It was noticed in the Introduction to the last volume, that the facilities which the Legislature had then just afforded for procuring salt at a reduced duty for agricultural purposes, had induced the Society to offer two Premiums of Thirty Guineas each, for practical experiments of its use as a manure, and in feeding live stock. Reports in competition were in consequence received, and premiums awarded in 1821, to Mr Andrew Robertson, a farmer in Linlithgowshire, and Mr Thrift Scott, a farmer at Dalgety in Aberdeenshire; but not appearing sufficiently decisive, the premiums were renewed for the subsequent year. A very accurate report of a well conducted set of experiments with salt as a manure, was accordingly received from Mr Peter Christian, at Mill of Forest, in Kincardineshire, to whom the first Premium of Thirty Guineas was voted,—and the Society was also favoured with an interesting communication from one of its members, General Dirom of Mount Annan, in Dumfries-shire, of certain experiments made by him. The result of these several reports, which will be found

in this volume, seems to be unfavourable to the use of salt as a *manure*. The information as to its effects in feeding and fattening of live-stock, though not conclusive, rather serves to confirm the general understanding, that in this respect salt may be employed with much advantage. In consequence of the deficiency of information on this head, the premiums for farther experiments with salt in feeding have been renewed.

7. *Curing Provisions.*

The repeal of the salt-duty during the last Session of Parliament, in so far as it applied to Scotland, induced the Society to direct the attention of Scottish Agriculturists to a new branch of industry, the curing of provisions. This art, so long and so beneficially practised in Ireland, if it cannot be said to be altogether unknown in Scotland, has at least, in some of its departments, been very little attended to. Many districts seeming well situated for introducing it with advantage, the Society accordingly offered a Premium of Thirty Guineas, for the greatest quantity of Beef cured, not under 20 tierces, in the counties of Aberdeen and Kincardine. The period for awarding the premium has not yet arrived, but it is satisfactory to know, that not only has the curing of provisions been already commenced within the district specified to a great extent, but that the attention of

a local association—the Agricultural Society of Aberdeenshire—has now been specially directed to the subject, and, from the exertions of that useful institution, it is hoped full effect will speedily be given to the measure within the countyof Aberdeen.

8. *Manures.*

It is generally admitted that much remains to be learned in regard to Manures, particularly in this part of the island, where the subject has been less attended to, and less understood, than on the other side of the Tweed. A great deal has been written, and experiment has also done much, to confirm or correct the various opinions which have been advanced in regard to the effect and the properties, mechanical and chemical, of the various manures, natural and artificial, calcareous and putrescent, or by whatever other names writers have chosen to class or distinguish them. It is obvious, however, to those who have paid attention to the subject, that some manures operate chiefly by mere mechanical division, thus inducing a change in the texture of the soil; while others supply that nourishment which a course of cropping never fails to withdraw from it. Of the former class, the calcareous manures present a familiar example, and the various descriptions of putrescent manures afford an equally familiar example of the latter.

With the view of directing the attention of farmers to this subject, the Society has, in the first instance, offered a Premium, to be decided in 1825, for the most satisfactory set of Experiments in raising Turnips with any manure, not farm-yard dung, by itself, or in compost. This premium, it is expected, will lead to some interesting experiments.

9. *Planting.*

While so much land has been planted of late years in Scotland, and so many of our hills, formerly barren and unproductive, are now covered with thriving trees, there still remain a great portion of the Hebrides, of the Islands of Orkney and Shetland, and many parts of the coast on the mainland exposed to the gales of the Atlantic and German Oceans, where hardly a tree or even a bush is now to be seen. There is sufficient evidence, however, from the many instances of large trees being dug from the mosses in those situations,—that wood must have at one time abounded there.

With the view of inducing proprietors to make proper experiments, conducted with skill and perseverance, in planting within such exposed and remote districts, the Society has, from time to time, offered Honorary Premiums. The success of some of these experiments was noticed in a former vo-

lume *; and in the present will be found reports of extensive plantations, very creditable to the public spirit of Lord Macdonald and the other proprietors, to whom the premiums have been awarded.

10. *Reclaiming Drift-Sand.*

A Report of the Experiments made in reclaiming an extensive tract of Drift-sand, in consequence of the premiums offered by the Society, as mentioned in the Introduction to Volume V. †, will be found among the papers in the present volume.

11. *Live Stock.*

Under this general title may be included all encouragements given, and rewards bestowed, for purposes connected with the improvement and management of our domestic Live Stock, towards which a very considerable sum is annually devoted by the Society. In some departments connected with the subject, measures of a more general description, although at present only experimental, have been put in operation, which, as they have already

* Introduction to vol. iv. p. 8.

† Introduction to vol. v. p. 29.

excited considerable interest, it is expected they may be attended with very beneficial effects, if continued for some time, and under judicious management.

1. *Black Cattle.*—Black Cattle constitute the staple commodity of many districts in Scotland, and the Society continues encouragements by premiums to a considerable amount, awarded annually at Local Shows, under the direction of resident Members, for improving the breeds more peculiarly adapted to each district.

2. *Horses.*—Premiums for improving the breed of Work-Horses are continued as formerly. The attention of the Directors has also been recently called to the expediency of encouraging, in certain districts, the rearing of a lighter and more active kind than the heavy draught-horse. Of horses for harness, for which the demand is now so great, for stage-coaches and public conveyances, very few have been reared in Scotland. With these we have been supplied from Yorkshire, Northumberland, or from Ireland. With a view, therefore, of encouraging the breeding of horses calculated for draught on the lighter soils, or for harness, according to circumstances, the Society has offered Premiums, in the first instance, in the county of Perth, which, probably, may be useful.

3. *Sheep.*—The Society has continued, and ex-

tended its range of Premiums for improving the breed of Sheep. It has been suggested, that, in corn districts, the finer breeds of Sheep might be advantageously combined with the arable management, although the practice is far from being general in Scotland. Premiums for the best Tups and Ewes of the improved Leicester and South Down breeds, have accordingly been given in a district round Perth, where a fair and satisfactory experiment has in consequence been made. Similar premiums are now offered in the districts of the Carse of Gowrie and Strathmore; while Premiums, for improving the Cheviot and Black-faced breeds, have been given in the county of Sutherland, and certain districts of the counties of Caithness, Perth, and Inverness.

The attention of the Society has also been directed to a race of small, fine wooled, and remarkably hardy native Sheep, viz. the *Shetland Sheep*, which, under the worst management, have been long distinguished by the quality of their fleece. This hardy race has been much neglected; and it has been thought, that, with proper care, and under a judicious system of management, they might be rendered a valuable breed, and worthy of being introduced into other parts of Scotland. The Society accordingly, in January 1823, offered a set of Premiums, to continue for some years; and an interesting Report, by James Baikie, Esq. of Tankerness, of the small flock, which he has se-

lected for experiment, in consequence of the Society's Premiums, will be found in this volume.

As connected with the improvement of sheep and wool, the Society has offered premiums for the best set of experiments, to be reported in 1825, in salving Sheep kept on hill-farms; and to the person in Scotland who should sell, from his flock of Merino sheep, the greatest quantity of pure Merino wool of clip 1823, for the purpose of being manufactured in Scotland into fine broad cloth. In consequence of this last premium, a Report has already been made by the Right Honourable Sir John Sinclair, Baronet, who keeps a large flock of Merinos on his estate in the county of Caithness, where they are stated to have hitherto thriven remarkably well.

GENERAL SHOW OF FAT STOCK.

In autumn 1821, some eminent practical agriculturists brought under the consideration of the Directors the expediency of establishing an annual Show of Fat Stock in Edinburgh.

The advantages which had resulted from similar shows in England, by exciting attention to the merits and properties of the various breeds of cattle, and the high perfection to which skilful management had in consequence brought some of the finer breeds in that country, gave reason to expect success from the like means employed in Scotland. The excellence of some of our native breeds was well

known; of which the hardy West Highland cattle afford an example. Much had been done, too, in this country already, by several eminent breeders in improving the native breeds; and the stock reared by these individuals has in consequence attained a great degree of perfection. But most of our practical farmers are little conversant in this art, and are acquainted only with the merits of the breed peculiar to their own districts. If, therefore, they attempt a change or a cross, they generally do so injudiciously, and without the necessary knowledge and attention to the end in view, whether this were the attainment of a better form, earlier maturity, or habits and constitution more fitted to the local situation. It was concluded, therefore, that the opportunity which would be afforded of bringing the different breeds, and the best specimens of the same breed, together in contrast, by means of this General Show, would necessarily lead to more attention to the subject, and to a better acquaintance with the habits, the properties, and the peculiar characteristics of the various breeds reared in Scotland.

The utility of the measure had been formerly discussed in the Society, but the limited state of its funds deterred the Directors from attempting the establishment of an exhibition at that time. Those members, however, who were more particularly desirous that an experiment should be made, were of opinion that, from the public spirit of our agriculturists, large pecuniary rewards would not be re-

quired, and that honorary premiums, added to the emulation excited, would attain the object in view.

Under these impressions the Directors proceeded. A Committee was appointed to regulate the necessary details; and at the anniversary meeting in January 1822, seventy guineas were voted to defray the expence of the experiment for the first year. This sum the Committee, guided by the assistance of practical farmers, divided into five classes of premiums, limited, in the first instance, to Black Cattle, and with one exception (the short-horned breed), to the breeds peculiar to this part of the island, and for cattle reared and fed by proprietors and tenants in Scotland,—first and second premiums of ten and five guineas being devoted to each class. The 1st class comprehended the short-horn breed; the 2d, Aberdeenshire cattle; the 3d, the West Highland; and the 4th, included Galloway, Fife, Angus, or any other breed: in the 5th class, first and second premiums were offered for the oxen shewing the most symmetry, fat, and weight, of any age or breed.

The Society was obligingly accommodated by the Barrack Department with the use of the inclosed area behind Queensberry-House, which afforded excellent accommodation for every purpose connected with the exhibition. The show of cattle of various breeds, as well in the competing lots as in those exhibited as extra stock, was very fine, and did great credit to the taste and judg-

ment of the exhibitors in the selection of the various classes. In awarding the premiums, the Committee of the Society had the assistance of farmers and dealers from various parts of the country, of acknowledged practical skill. The show-yard also admitted of excellent arrangements being made for the accommodation of the public, who came to view the stock; and the exhibition having excited great interest, it was crowded during the day. The fine cattle which obtained the premiums, and indeed the greater part of the stock shewn, were sold on the spot at high prices; and on the whole, this experiment of a fat stock-show equalled the best expectations which had been entertained of it.

The Committee, under whose directions it was conducted, having recommended the extension of the premiums to other descriptions of stock, the Society, at the succeeding anniversary meeting, voted a hundred guineas for promoting the object, and continuing the experiment in 1823. This sum enabled the Committee to continue the premiums for Black Cattle to the same amount as in 1822, and also to extend them to the best kinds of fat Sheep of the black-faced, South Down, Cheviot, and improved Leicester breeds, and to the three best specimens of fat Pigs.

SOURCES OF INDUSTRY PECULIAR TO THE HIGHLANDS AND ISLANDS.

The Society having been originally instituted with a view more particularly to advance the improvement of the Highlands and Islands, has not ceased to direct its attention, and to allot a large share of its funds, to this important purpose. The exertions of the Society in improving the Fisheries, —the Roads and Bridges, and other public works, —the manufacture of Kelp, and such other sources of industry as existed in the Highlands,—have been particularly noticed in the Introductions to former volumes.

1. *Kelp.*—It appeared to the Society, that although, by means of its premiums, much information had been obtained, regarding the manufacture and analysis of kelp, the object was still deficient, without promoting improvement in its specific qualities. A series of premiums were therefore announced for the best kelp, in quantity not under 20 tons, which were to be decided, in the first place, in 1822, for that manufactured on the coasts of the counties of Inverness and Ross, including their Islands. The result of the analysis of the best specimens, with some account of their manufacture, will be found among the papers in this volume. The premiums in other districts are continued.

In the present volume, also, there is an interesting paper by Dr Fyfe, on the means of increasing the quantity of alkali yielded by kelp, the suggestions in which may lead to results highly important to this branch of manufacture.

Not many months ago, the interests of the manufacturers of kelp were in danger of being suddenly and deeply affected, and at a time when the population in the Highlands were also suffering severely from the great depression in the price of black cattle and sheep. At the anniversary meeting of the Society in January 1823, the Society learned, that, within a few days of the rising of the session of Parliament immediately preceding, an act had been very unexpectedly passed, reducing the duties on the importation of barilla,—a foreign commodity which may be substituted in several of the most important manufactures in which kelp is used, and nearly, if not entirely, to the exclusion of the latter article. The subject having been previously submitted to the Directors, had undergone much discussion and inquiry; and the Society now considering that the manufacture of kelp affords employment and subsistence, during a considerable part of the year, to a numerous and dependent population in the Highlands and Islands; —that the ruin of that manufacture, or any measure tending to the sudden depreciation of kelp in the market, might be attended with alarming consequences at such a moment, and especially when the public

works which had for a long time been carrying on in the north of Scotland were nearly completed,—unanimously remitted to the Directors to submit a Memorial to Government, in order to obtain, if possible, the concurrence of Administration to the applications which were contemplated for a repeal of the act. A memorial to the Treasury was accordingly transmitted; and it was very satisfactory to the Society to find, that the representations made to the Legislature and Government were attended with the desired effect.

2. *Sea-Grass* (Zostera marina, *Lin.*)—In 1821, a communication was submitted to the Society from Mr Robert Johnston, secretary to the Asylum for the Industrious Blind in Edinburgh, stating that quantities of this marine plant had lately been imported from the Continent, and used very succesfully in stuffing matresses, cushions, and for such like purposes, as a substitute for horse-hair; and that it being understood that the same, or a similar plant, was found in abundance on some of the Scottish shores, particularly in the Western Islands, it might be expedient to institute an inquiry on the subject. A small Committee was accordingly named, under whose directions specimens of the Zostera were procured from various parts of the Highlands and Islands. A Report was made by the Committee in January 1822, stating the result of their inquiries to be, that the zostera found on some of our shores answered equally well with that imported from

Hamburgh, &c.;—that carefully washing the plant, in fresh water, in order to extract a portion of the salt, and quick subsequent drying to preserve its elasticity, was all the preparation required for the purposes to which it was to be applied. The Committee therefore suggested, that it might be proper to stimulate the Islanders to avail themselves of a new branch of industry, which they could practise at the same time that they are engaged in cutting sea-weed for kelp.

Premiums were accordingly offered, to be decided in 1823; and it is satisfactory to find, from the accurate and detailed reports given in this volume from Mr Traill Urquhart of Elsness, and from Mr Baikie of Tankerness, the gentlemen to whom the premiums have been awarded, that they have been attended with the desired effect. The supply of the *zostera* afforded from our own shores, is already sufficient to supersede the necessity of importation.

Present State of the Highlands and Islands.

The changes which have taken place and are still in operation, in various districts of the Highlands and Islands are well known; and the exertions of the Society in directing the attention of the inhabitants to various sources of industry within their reach, have just been adverted to. With a view to a more extended and successful prosecution of this interesting subject, a premium, in the following terms, was

offered in January 1823, which it is expected may elicit some useful information.

"A Piece of Plate of Fifty Guineas value, will be given for the best and approved Essay on the present state of the Highlands and Islands of Scotland, Agricultural, Manufacturing, and Commercial;—the progress and influence of those changes at present affecting their condition, and the means of deriving from these changes, for the benefit of the population at large, the greatest portion of good, and rendering such as have an unfavourable tendency productive of the least possible degree of evil. This Essay to be lodged with the Secretary, at the Society's Chambers, on or before the 10th November 1824."

MACHINERY.

Invention and Improvement of Machinery more particularly connected with Agriculture and Rural Economy.

Within the period to which this introductory notice relates, various articles in this department have been submitted to the Society, and suitable pecuniary rewards, or honorary notices, voted to the authors and inventors, upon Reports submitted from time to time, by the Society's Committee on Mechanics. Engravings and descriptions of several of these articles in machinery will be found in this vo-

lume. The first of these in importance, are the papers and models lodged in consequence of the premiums offered for the best Essays on the improvement of

Rail-Roads.

It will be seen from former volumes, that the Society, from its earliest institution, directed its attention to the means of facilitating the communication with the remote districts of the Highlands of Scotland, by means of roads and bridges. The importtant object in view having been happily attained by the joint operation of thepublic aid so liberallyafforded, and the exertions of the proprietors,—the Society, as noticed in last volume, proceeded to consider the means of facilitating conveyance by means of Rail-roads, which, it was thought, might be adapted to more general use than they are at present. The general result of the information acquired, will be found in the first paper published in the volume; —an abstract, prepared from the various Essays and Models received, by Mr Stevenson, civil engineer, a gentleman whose professional experience rendered him well qualified for such a task. There is reason to expect that the suggestions in these papers may lead to farther improvements, and ultimately to very important practical results.

Stoves for Cottages.

At the General Meeting in January 1822, the Earl of Elgin presented to the Society the model and description of a stove which his Lordship had seen in use in the Netherlands, and which, with a view to an economical and advantageous application of fuel, promises much benefit to the cottager, in situations where there is a scarcity of this most necessary article. The thanks of the Society were voted to Lord Elgin, and an engraving and description of the stove ordered to be published; which are given in this volume.

Odometer or Road-Measurer.

At the General Meeting in January 1821, James Hunter, Esq. of Thurston, presented an instrument improved by him, very convenient, and of ready application, for measuring distances, or the lengths of walls, ditches, &c. This instrument Mr Hunter has called an Odometer; and an engraving and description of it are now published. For it and the self-acting pump, noticed in last volume, the Society's Gold Medal was voted to Mr Hunter.

Instrument for ascertaining the Composition, Thickness, &c. of Mineral Strata; and Apparatus for boring in Quicksands.

Ten Guineas were voted at the General Meeting in July 1822, to Mr John Busby, mineral surveyor, for an instrument invented by him for ascertaining the Composition and Thickness of Strata at different depths, in boring for coal, and other minerals, of which a description and relative engraving are now published. An account of the apparatus, and method practised by Mr Busby for sinking through quicksands, will also be found among the papers published in the department of mechanics, in the present volume.

Milk-Churn.

A premium was voted by the General Meeting in January 1823, to Mr George Firth at Bayfield, in the Island of Sanday in Orkney, for a method devised and practised by him, in applying the impulse of wind on sails to work a Milk-Churn. By this expedient, a saving of labour is obtained. A drawing and description of the Churn are contained in this volume.

Implement for Sweeping Chimneys.

The Society's Silver Medal was voted at the General Meeting in July 1822, to Mr James White,

civil engineer, Edinburgh, for a model and description of an ingenious machine invented by him, intended to supersede the necessity of climbing-boys in sweeping chimneys. A description of this machine, with an engraving, are given in this volume.

Instrument for measuring Standing Timber.

In 1821 the Society voted Ten Guineas to Mr Robert Monteath, wood-surveyor, Stirling, for an instrument invented by him for measuring growing timber. As there is an engraving and description of it in a book lately published by Mr Monteath, intituled "The Forester's Guide," any farther detail is here unnecessary.

Machine for Sowing and Watering Turnips.

It was noticed in last volume, that the Society had voted a premium to Mr John Common at Denwick, near Alnwick, for an Improved Double-drill Turnip Sower. A model of this machine, with an additional apparatus for watering the drills in dry seasons, was submitted to the Society in 1822, by Mr James Crozier, nursery and seeds-man at Alnwick. By means of the apparatus supplied by Mr Crozier, the drills are watered, and the moisture covered in with the seed at the time of sowing. The moisture thus applied consequently can-

not be rapidly evaporated, nor is the soil so liable to become hardened, as when the surface is watered, or heavy rains fall, after sowing. A model of this improved machine is deposited with the Society.

Steam-Boat for Canal Navigation.

In 1822 the model of a Steam Boat on a new construction was submitted to the Society, by Mr Robert Wight, *jun.* Abercromby Place. The plan proposed, as shewn by the model, was, by introducing and conducting the water through the vessel, by means of a passage or channel passing from the bow direct through the centre of the vessel, under the cabin floor, to the stern, where the channel becomes a little wider. One paddle-wheel in the centre of the vessel is to be driven by a steam-engine, and to act on the water in the channel at a proper distance from the bow. The channel is proposed to be made a little wider from the wheel to the stern, in order that the hydrostatical pressure of the broken water may be exerted obliquely in assisting to propel the vessel forward.

The Committee for Mechanics having been of opinion that a boat of the proposed construction, if found to answer, might be calculated for Canal Navigation, because the breadth of the vessel would be necessarily less, and the agitation of the water occasioned by the wheels at the sides, in the common case so injurious to the banks of canals, would be

chiefly confined to a line in the centre or wake of the boat; they recommended, that a sum should be voted towards the expence of having a boat made on a scale sufficiently large for practical experiment. Fifteen guineas were accordingly paid for this purpose; and an experiment was made with a boat of about 28 feet in length, and about ten tons burden, prepared by Mr Wight in consequence; the general result of which seemed favourable to the plan suggested. A short account of Mr Wight's boat is given in this volume, with some Explanatory Notes by Mr Stevenson.

Syrian Plough.

At a General meeting in July 1821, the thanks of the Society were voted to William Rae Wilson Esq. of Kelvinbank, for the model of a plough which has long been used in a great part of the East, and which was brought by him from Nazareth in Syria, when recently travelling in that country, and deposited by him with the Society.

GENERAL PUBLIC MEASURES.

Agricultural Depression.

It is well known, and therefore requires to be merely mentioned, that during the period to which this account extends, the agriculture of the country

has been in a state of very unusual depression;—and that all those whose income or means of support were dependent on its prosperity, have been subjected to great distress. This state of agriculture has been ascribed to many causes,—to a transition from war to peace,—to a rise in the value of money,—superabundance of produce,—import of foreign grain, and a variety of others. Into any discussion of these, however, it is unnecessary here to enter, although probably the opinion that the depression has been owing to a combination of these causes operating in a greater or less degree, and at nearly the same time, is not the least deserving of attention. But if great difference of opinion prevailed in regard to the *causes*, opinions were at least equally divided as to the *remedies* proper to be applied.

The attention of the Society was explicitly called to this subject, by a motion, submitted by the Right Honourable Sir John Sinclair, Baronet, seconded by Sir James Ferguson of Kilkerran, Baronet, at the Anniversary Meeting on 8th January 1822,—"That it be an instruction to the Directors to take into their early and most serious consideration the distressed state of the landed and farming interest, with authority to them to take such steps as the circumstances of the case may require, with the view of suggesting proper remedies for these distresses."

The Directors, on their part, referred the remit to a select Committee, with instructions to consider it with that deliberation which its importance merited;

and to report their opinion thereupon. The subject underwent much discussion in the Committee, and various suggestions were made, but none of them appeared likely to lead to such an immediate or practical measure of relief, as to render them worthy of being recommended for adoption ; and, in consequence of the difference of opinion which was found to prevail as to the cause of the distress, and the remedies proper to be applied, the Committee reported, " That it is the opinion of this Committee, that it would be expedient to make still farther enquiry into the causes of our agricultural distresses, and the means of remedying them, and with the view of obtaining information, that a premium be offered in the follow-terms :

" A piece of Plate of Fifty Guineas value will be given for the best and approved Essay, shewing, *First*, The nature and extent of the embarrassments at present experienced by the agricultural interest ; and, *Secondly*, What is the suitable remedy for these embarrassments ;—the Essay to be lodged with the Secretary on or before the 1st June 1822."

The Directors having approved of this suggestion, a Premium was immediately advertised, to be decided in June following, so that any useful suggestions or measures of relief, which the information to be obtained might possess, should be submitted in the proper quarter, or the information given to the public without delay.

No fewer than fifteen competing Essays were lodged, in several of which the subject was treated with great ability. The Committee appointed to

examine them gave their opinion, that the Essay having for its motto, " *Tu ne cede malis sed contra audentior ito,*" was the best; and upon opening the sealed note referable to this Essay, the author was found to be Mr James Cleghorn, Editor of the Farmers' Magazine, to whom the Premium of Fifty Guineas was voted accordingly. In pursuance of the instructions of the General Meeting on the 1st July, the Essay was immediately published as a pamphlet, in a size uniform with the volumes of the Society's Transactions; a sufficient number of copies being thrown off to enable the publishers to deliver a copy of the Essay with the present volume, to such members of the Society as may not have been previously possessed of it.

2. *Distillery Laws.*

To the important subject of the Distillery Laws, the attention of the Society has been directed from time to time from 1806 downwards. In the introductions to Volumes IV. and V. the measures taken by the Society for suggesting to Government certain alterations in the laws relating to the distillation of spirits, and of adapting them to the situation and local circumstances of the Highlands of Scotland, have been detailed. The object of the Society has uniformly been to procure such modifications in the law, as should lead to the general establishment of small stills, as the best means of repressing the pernicious practice of illicit distillation, which has for some years prevailed in many of the highland and

more remote districts of the country; a practice not less injurious to the revenue, than to the moral habits of the people.

In 1821, a Committee of the Society was named to enquire into the causes which had obstructed the operation of the act of 1816, and the subsequent statutes, which authorised the licensing of small stills. Under the directions of that Committee, a set of Queries was printed and transmitted to the Conveners of the different counties where the illicit trade chiefly prevailed, with the view of being circulated to such individuals of intelligence and impartiality, as had best access to afford the information required. In answer to these queries, a great mass of information was obtained, the result of which was embodied in a Report submitted by the Committee in July 1822. This Report was printed and circulated by the Society to the members of Administration, the different members of Parliament connected with Scotland, and, the Conveners of the different counties.

The Commissioners appointed by Parliament to enquire into the collection and management of the revenue in the United Kingdom, having directed their attention to the state of the laws relating to distillation,—in the progress of their inquiries in Scotland in autumn 1822, made a communication that they would be happy to receive such information as it was in the Society's power to afford. The whole information in possession of the Society, and upon which the various Reports of its Committees

were founded, was in consequence communicated. The Commissioners were actuated with the most anxious desire to give the subject the fullest investigation, and took every means to collect the best and most authentic information, by an examination of the land-owners, officers of the Revenue, and others, who had best access to be acquainted with the subject.

In the Report prepared by the Commissioners, as the result of their inquiries, many salutary recommendations are submitted; in pursuance of which a bill was introduced, now passed into a law, whereby a great reduction of duty is conceded, and many of the restrictions in the process of distillation, operating against the production of a mild and palatable spirit, have been repealed or modified. To the progress of this bill, the Committee of the Society anxiously attended, and from time to time submitted observations on certain clauses, which it was satisfactory to find were not overlooked. The liberal views taken by the Legislature, it is hoped will be attended with the best consequences; and if some restrictions still remain, which it would be desirable should also be removed, with the view particularly to the situation and circumstances of certain districts of the country, it is not doubted that these will also be altered, if experience proves that this can be done consistently with the security of the revenue.

3. *Friendly Societies.*

It was mentioned in the introduction to last volume, that the Society had been induced to institute an investigation into the constitution and management of *Friendly Societies* in Scotland, and a copy of the premiums offered, with the view of obtaining the necessary information, was published in the appendix to that volume. Friendly or Benefit Societies, institutions so useful in themselves, from having been formed on erroneous principles and calculations, were continually failing in their object, and falling into decay; but it was expected, that, by means of the inquiry instituted by the Highland Society, such information might be procured, founded on the experience of existing Friendly Societies in Scotland, as might afford *data* whereon to make the necessary calculations in constructing Tables for their after guidance.

In entering on this investigation, the Society was not insensible to the many difficulties which attended it, and the Directors entertained no very sanguine views of the inquiry leading to useful practical results. Doubts were also entertained whether it was strictly within the purposes which this Society was instituted to promote and encourage; but the object was one in itself so important, that these objections were waved, and a general meeting agreed to authorise the Directors to proceed with the inquiry.

The premiums competed for were awarded in

November 1822, and it was very satisfactory to find, that, previous to this period, Returns of the experience of a great many Friendly Societies from all parts of Scotland, were received by the Committee, under whose superintendance the inquiry proceeded. Most of these Returns were prepared in a way which did much credit to the members of the different Friendly Societies who had the charge of filling them up.

Immediately after the premiums were awarded, the various Returns were referred to the Committee, to proceed to arrange and digest the information contained in them, and with the advice and assistance of professional actuaries and accountants, to make the necessary calculations, and construct Tables, which might be adapted to the purposes of Friendly Societies in different situations and circumstances.

A full Report on the whole matter, with relative calculations and tables, is given in this volume; and if the result of the investigation, and the practical use of the Tables, shall be found in any degree commensurate to the industry and care with which the inquiry has been prosecuted, the Highland Society will not have cause to regret having embarked in it. But this, perhaps, experience alone can sufficiently determine. In the mean time, it is due to Mr Charles Oliphant, the indefatigable Convener of the Society's Committee on this business, to say, that to him must be ascribed much of any merit that may arise from the inquiry: On his motion it was originally instituted, and from its nature, a great ac-

cumulation of detail in the course of its progress, and of labour in its last stage, were necessarily imposed upon him. The Committee state, that the assistance of professional actuaries and accountants, in making the necessary calculations, has been most obligingly furnished, and that they have been particularly indebted in this department of the duty, to Mr Lyon, House Governor of Watson's Hospital, Edinburgh.

4. *Weights and Measures.*

Although the Society has ceased to take any active charge, in regard to this important object, since the investigations connected with it have been carried on by Commissioners appointed by his Majesty; the Society continues to look forward to its ultimate attainment with a lively solicitude. Since the publication of last volume, the Commissioners have made a second and third report. In their first Report, dated 24th June 1819, they give their opinion, that " there is no practical advantage in having a quantity commensurable to any original quantity, existing, or which may be imagined to exist, in nature, except as affording some little encouragement to its common adoption by neighbouring nations. But it is scarcely possible, that the departure from a standard, once universally established in a great country, should not produce much more labour and inconvenience in its internal relations, than it could ever be expected to save in the operations of foreign commerce and correspondence, which always are, and

always must be, conducted by persons to whom the difficulty of calculation is comparatively inconsiderable, and who are also remunerated for their trouble, either by the profits of their commercial concerns, or by the credit of their scientific acquirements."

"The subdivisions of weights and measures, at present employed in this country, appear to be far more convenient for practical purposes than the decimal scale, which might perhaps be preferred by some persons for making calculations with quantities already determined. But the power of expressing a third, a fourth, and a sixth of a foot in inches, without a fraction, is a peculiar advantage in the duodecimal scale; and, for the operations of weighing and of measuring capacities, the continual division by two, renders it practicable to make up any given quantity with the smallest possible number of standard weights or measures; and is preferable, in this respect, to any decimal scale. We would therefore recommend, that, all the multiples and subdivisions of the standard to be adopted should retain the same relative proportions to each other, as are at present in general use."

The final recommendations of the Commissioners is thus given in their last Report:

"1. That the Parliamentary standard yard, made "by Bird in 1760, be henceforward considered as "the authentic legal standard of the British Em- "pire; and that it be identified, by declaring, that "39.1393 inches of this standard, at the tempera- "ture of 62° of Fahrenheit, have been found equal

"to the length of a pendulum supposed to vibrate "seconds in London, on the level of the sea, and in "a vacuum.

"2. That the Parliamentary standard Troy "pound, according to the two pound weight made "in 1758, remain unaltered; and that 7000 Troy "grains be declared to constitute an avoirdupois "pound; the cubic inch of distilled water being "found to weigh, at 62°, in a vacuum, 252.72 Par-"liamentary grains.

"3. That the ale and corn gallon be restored to "their original equality, by taking, for the statu-"table common gallon of the British Empire, a mean "value, such that a gallon of common water may "weigh 10 pounds avoirdupois in ordinary circum-"stances; its content being nearly 277.3 cubic "inches; and that correct standards of this Impe-"rial Gallon, and of the Bushel, Peck, Quart, "and Pint derived from it, and of their parts, be "procured without delay, for the Exchequer, and "for such other offices in your Majesty's dominions "as may be judged most convenient for the ready "use of your Majesty's subjects."

It cannot be otherwise than gratifying to the Committee of the Society, to find, that the result of the inquiries of gentlemen, so eminent for their scientific acquirements as these Commissioners, has led them to adopt the same general views as are suggested in the Society's original Report, noticed in the Introduction to vol. iv. pp. 27—31.

The Reports of the Commissioners were communicated to Parliament: A Select Committee of the House of Commons was appointed to consider them, and their Report concurs in the views of the Commissioners, in recommending that the subdivisions of weights and measures employed in this country be retained, as being far better adapted to common practical purposes than the decimal scale. They also coincide in opinion with the Commissioners, as to the plan by which the details are to be regulated.

A bill was accordingly introduced into Parliament last session, and passed the House of Commons, to give effect to these recommendations; but it was again arrested in its progress in the House of Lords, and a Select Committee appointed to report to their Lordships thereupon. It is understood that the Committee have not yet submitted the result of their deliberations, but, it is hoped that the measure is in a train of speedy accomplishment.

5. *Lectures on the Veterinary Art.*

It has for some time been matter of regret to those immediately interested in the management of livestock, that no permanent institution exists in this part of the island to promote a knowledge of the diseases, cure, and treatment of our domestic animals. Such have long been established in most of the

principal states on the Continent; and, more recently, a Veterinary College has been instituted in London, supported by the bounty of Parliament.—The Dublin Society, also, which receives a liberal annual grant of public money, among the other beneficial objects which it has promoted, has established a veterinary institution in Dublin. But nowhere in Scotland has instruction been afforded in the veterinary art, either by public or private lectures, and only a very few regularly educated veterinary surgeons are established in this country. The consequence is, that our farriers and others, who pretend to the knowledge of the diseases of horses and other cattle, are, in general, lamentably ignorant of what they profess to understand and to practise.

The subject was brought under consideration in summer 1823. The Society was sufficiently alive to its importance, and being intimately connected with the advancement of agricultural science, it was agreed that a Lecturer sufficiently qualified should be patronised in a course of lectures. Accordingly, the General Meeting, in June 1823, placed the sum of L. 50 at the disposal of the Directors, for promoting the measure in the session of 1823-1824, upon the understanding, that, as far as regards the Society, it was entirely experimental.

The Committee, to whose superintendence the arrangement of all the details was entrusted, immediately applied themselves to carrying the views of the Society into effect, and they have made the necessary arrangements with a Graduate of the Veterina-

ry College of London (Mr Dick,) of whose zeal and practical skill they had received very satisfactory testimonials. The lecturer, furnished with a forge and other appendages for the practical instruction of country farriers, has accordingly begun his first course of lectures on the diseases of horses, black cattle, sheep, and other domestic animals, illustrated with the necessary anatomical demonstrations. The result will afford better means for determining how far, and in what manner, it may be expedient and practicable for the Society to encourage such an establishment, with a view to its permanency and efficiency.

Celtic Literature.

Gaelic Dictionary.

The proceedings of the Society preparatory to and in prosecution of the purpose of compiling a proper Dictionary of the Scoto-Gaelic Tongue, were detailed in the introductions to the two last volumes of its Transactions. Henry Mackenzie, Esq. is Convener of the Committee, to whose superintendence that measure was entrusted; and the Committee, during the period to which this account relates, have been unremitting in their endeavours to have the compilation of the dictionary advanced to completion. The labours of the compilers were for some time unfortunately retarded by the death of Mr Ewen Maclachlan of Aberdeen, who, as a coadjutor to the

Rev. Dr Macleod, had been employed in the compilation.

The Committee having afterwards made arrangements for taking the assistance of the Rev. Dr Alexander Irvine of Dunkeld, and the Rev. Mr Alexander Macdonald at Crieff, to supply the place of Mr Maclachlan, the several compilers have been industriously occupied during the last year in the departments assigned to them, and it is expected, that the Manuscript of the whole will be in possession of the Society previous to the General Meeting in January 1824.

The Society has lately voted a small sum to the Rev. Mr Maccallum of Arisaig for some Gaelic Poems published by him, and to Captain Simon Fraser, for a second collection of his Ancient National Melodies, the first collection of which was published in 1816, as noticed in the Introduction to Vol. IV.

CORRESPONDENCE WITH OTHER INSTITUTIONS.

The Society continues to cultivate a correspondence with other institutions at home and abroad, established for promoting important public objects; and, with many of the local agricultural Societies of this country, in matters interesting to the districts in which these Societies are established. To several distinguished individuals, too, who have been resident in our colonies, the Society has been frequently indebted, for their attention in transmitting

for experiment the seeds of any plants peculiar to these colonies, that might probably be raised with advantage in Scotland. During the period of this account, the Society has particularly to notice the obliging attention of the Marchioness of Hastings, one of its members, who has sent from India for experiment various seeds of grasses, and, particularly, of late, a parcel of a peculiar kind of *wheat*, which is recommended as uncommonly prolific. The Directors have distributed small quantities of it among some eminent farmers, who are to make trial of its properties in this country.

This Society, instituted in 1784, is the oldest Agricultural Association at present existing in Scotland; but since the date of its institution, local agricultural societies have been very generally established; and the exertions of these local societies have been productive of the best results to the districts in which they are established. Some of them, from the recent agricultural depression, and other causes, have become extinct, or have been dissolved; but many still continue in the active exercise of their useful labours. To the recommendations of these, the Directors of this Society are ready at all times to give attention, satisfied that from no source are suggestions likely to be received more deserving of consideration.

THE LIBRARY.

The Library of the Society has not hitherto been so much enlarged, as several members, whose opinions are well entitled to regard, have wished. Publications of merit, connected with agricultural and rural economy, have, however, been gradually added to it by purchase. It has likewise received some valuable accessions from the publications of other public institutions or individuals, which have been presented to the Society. Several publications of local or general application, connected with Scottish agriculture, have been dedicated to the Society, during the period of this account, among which may be noticed Mr Robertson's, on the improvement of the Hebrides, and Orkney and Shetland Islands; Dr Storey, on certain diseases of Cattle; Mr Finlayson, on the improvement of Moss, &c.

The Society having now purchased premisses for a Hall, and to afford the additional accommodations which the extension of its business requires, sufficient provision has been made in the arrangement of the new building, for the library of the Society, with a view as well to its present extent as to its progressive enlargement.

It may be noticed also, as connected with this subject, that the Directors have now likewise made arrangements, in pursuance of which the volumes of the Society's Transactions will be afforded to members at a cheap rate.

PROCEEDINGS OF THE SOCIETY ON THE OCCASION OF HIS MAJESTY'S VISIT TO SCOTLAND.

It will be seen by the introductions to former volumes, that the Society has, on all proper occasions, taken an opportunity of publicly testifying its loyalty to the Throne and attachment to the Constitution. Its members are chosen from all parts of Scotland, and, from their great number and respectability, the Society's Addresses to the Throne, as former volumes have recorded, may, in some measure, be considered as speaking the united voice of the Nobility and landed interest of Scotland.

On no previous occasion, since the institution of the Society, has a more gratifying opportunity been afforded to Scotchmen, individually or collectively, of laying their sentiments at the foot of the Throne, than during His Majesty's visit to Scotland; an event which diffused a joy, and excited an enthusiasm, so intense and so universal in Scotland, as perhaps had not been exceeded by any previous occurrence in its history.

Immediately on its being ascertained that His Majesty was to visit Scotland, the Directors summoned an Extraordinary General Meeting to be held on the earliest day to which, by the Society's Charter, it could be called, for the purpose of considering the expediency of voting a loyal and dutiful Address of Congratulation. The draft of an

Address, prepared by a Committee, having been approved by the Directors, at a Meeting at which the Marquis of Lothian presided, his Lordship undertook to represent to His Majesty's Principal Secretary of State the Society's claims to some distinction, with reference to the form in which its Address should be received.

At the Extraordinary General Meeting on the 9th of August, at which about 300 Noblemen and Gentlemen attended, the Address having been moved by the Earl of Wemyss and March, and seconded by the Earl of Breadalbane, was unanimously adopted; and it was at same time resolved, that, in the event of its being received by a Deputation, that Deputation should consist of the Noblemen and Gentlemen who had held the office of President or of Vice-Presidents, and of the three senior Ordinary and one of the Extraordinary Directors.

Previous to the arrival in Edinburgh of the Duke of Argyll, then President of the Society, the Marquis of Lothian had received such communications as authorized his Lordship to intimate, that, at all events, the Society's Address would be received by a Deputation; and after the arrival of his Grace, His Majesty's most gracious order was obtained, that the Society's Address should be received in the *Royal Closet*.

Monday, the 19th of August, having been fixed for receiving the Addresses from those Public Bo-

dies which were to have the privilege of presenting them on the Throne or in the Closet, the Members of the Deputation of the Highland Society assembled at the Waterloo Hotel, and thence proceeded in their carriages to the Palace of Holyroodhouse: such of the Deputation as were officially in attendance on the King, joined at the Palace. This Deputation, constituted on the principle already mentioned, consisted of the following Noblemen and Gentlemen, viz.

The Duke of Argyll, *President*, and the Marquis of Lothian and Viscount Arbuthnot, *Vice-Presidents*, in office; the Dukes of Hamilton, Athol, and Montrose; the Marquis of Queensberry; the Earls of Morton, Moray, Lauderdale, Elgin, Wemyss, Aboyne, Breadalbane, Rosebery, Fife, Rosslyn, and Cathcart; Viscount Melville, Lord Glenlyon, Right Honourable Sir John Sinclair, Baronet, James Hunter, Esq. of Thurston, and William Macdonald, Esq. of St Martins,—attended by the *Treasurer* and *Secretary* of the Society.

The Duke of Argyll, as President, read the Address.

"TO THE KING.

"Most gracious Sovereign,

"The HIGHLAND SOCIETY of SCOTLAND, constituted by Royal Charter, assembled in an Extraordinary General Meeting, humbly approaches the Throne, in all its national warmth of loyalty, with its most sincere congratula-

tions on your Majesty's presence in this ancient Kingdom. The Society rejoices in the present opportunity of offering its dutiful homage, afforded by the benignant care of your Majesty, in visiting your Majesty's faithful Subjects of Scotland, from which the Society anticipates the happiest results.

"The best energies of this Society have been unremittingly directed to stimulate the industry of your Majesty's People, and it is confident that your Majesty's paternal interest in the welfare of your Majesty's Subjects, will be gratified by the information which it has the satisfaction of laying before your Majesty, of the advancement of Scotland in Agriculture, Manufactures, and the other objects which it is the peculiar purpose of this Society's Institution to promote and encourage. The same animated spirit for improvement, and the same pious observance of the Moral Virtues, which have so long distinguished the Scotish Nation, remain uninterrupted, and are disseminated in active exercise throughout the Kingdom.

"The Highland Society of Scotland, embracing a very large proportion of the Rank and Property of this part of the United Kingdom, begs leave earnestly to assure your Majesty of the unalterable loyalty, and of the faithful attachment of the Scotish People to your Majesty's sacred Person, and of their profound veneration for that happy Constitution, which has ever proved the safeguard of your Majesty's Subjects, as it has been the bulwark of the British Empire.

"Sealed with the Seal of the Society, and signed by the Most Noble William Marquis of Lothian, one of the Vice-Presidents in office, in presence and at desire of the Meeting.

"LOTHIAN, *V. P.*"

EDINBURGH,
August 9. 1822.

To this Address, His Majesty was pleased to return the following most gracious Answer:

"I thank you for this loyal and dutiful Address.

"It will always be gratifying to me to hear of the success of a Society which has for its object the encouragement of the Agriculture and Manufactures of Scotland."

As the only addresses received by His Majesty on the Throne were those from the Church of Scotland, and the Four Universities; and those presented in the Royal Closet, were the addresses from the Clergy of the Episcopal Church of Scotland, and from the Highland Society of Scotland,—the Society must deem it a most distinguished mark of His Majesty's favour, and approbation of its exertions, to have appointed this form of receiving its Address.

It may be noticed also, that, on occasion of His Majesty's visit, the foundation-stone of the National Monument for Scotland was laid by Commissioners named by His Majesty; and the Committee of Management officially intimated by their Secretary, that, as a mark of attention to the Society, a plate was deposited with an inscription commemorative of the circumstance that the proposal for such a monument had originated in a motion at the Anniversary Meeting of the Society on 9th January 1816.

Resolution of the Society, on the Retirement of Mr Lewis Gordon, the Depute-Secretary.

Mr Lewis Gordon entered the service of the Society in 1792. From that period to the year 1821, he discharged the varied official duties of the situations he filled in such a manner as to merit the uniform approbation of every member of the Society. Few officers, in like situations, have evinced so much zeal, united with a sound discretion, in the exercise of their official duties, as Mr Gordon; and when the state of his health obliged him, in 1821, to relinquish the active duties of the office of depute-secretary of the Society, and to retire to the country, the Directors felt it due to him, that the minutes of the Society should bear a permanent record of the sense which the Society entertained of his unremitting and important services. With this view, at the Anniversary Meeting, on 8th January 1822, Mr Macdonald of St Martins having obtained the previous hearty concurrence of the Directors, submitted the following motion, which was unanimously agreed to:

"That this Meeting, taking into their consider-
"ation the many important services rendered to
"the Society by Mr Lewis Gordon, their Depute-
"Secretary, for a period of thirty years, during
"which he has been in their employment, are of
"opinion, that he well deserves some decided mark
"of their entire approbation of his conduct during

" that long period; they therefore resolve, That " the thanks of the Society be given to Mr Gordon, " and direct their Secretary to communicate the " same to him; and farther, that a piece of Plate, of " the value of Sixty Guineas, with an inscription, " commemorative of his meritorious exertions, be " presented to him: and they remit the matter to " the Directors, that they may carry this resolution " into effect, and report their having done so to next " General Meeting."

The instructions of the Society contained in this resolution have accordingly been fulfilled.

CONCLUSION.

Such is a general view of the proceedings of the Highland Society of Scotland within the last three years;—and it is hoped there is sufficient evidence that there has been no want of exertion, zeal, or attention, on the part of those who, during that time, have been entrusted with the charge of its business. The Directors, no doubt, have sometimes found their usefulness circumscribed by the want of such public pecuniary assistance as is afforded to similar institutions in Ireland, and which for some time was bestowed on this Society; and measures have at various times been proposed, which were either postponed or abandoned, from their necessarily requiring larger funds for their prosecution and accom-

plishment, than could be spared out of the revenue of the Society; such as instituting the necessary investigations and experiments for a general *Nomenclature of Soils*,—for establishing an *Experimental Farm*,—and for a general *Mineralogical Survey* of Scotland (more especially of the Highlands and Islands, where it is supposed much remains to be explored), with other similar inquiries, physical and statistical, which could be specified as examples. But if some departments of inquiry have been delayed, from want of public pecuniary support, it has been thought by many members, that this circumstance is not a little counterbalanced by the additional energy and zeal which not unfrequently characterise the proceedings of institutions for patriotic purposes, which are supported exclusively by the voluntary subscriptions of members, and by such a capital as, by a prudent administration of the funds, may thence be realised.

It only remains to notice, in conclusion, what indeed the public will readily anticipate, that the Society, *as a body*, is not responsible for any opinions or representations of facts contained in their volumes, farther, than that due care has been taken by the Committees, to whose consideration the papers and inventions were severally referred, to ascertain their accuracy and authenticity, so far as circumstances would admit.

HIGHLAND SOCIETY CHAMBERS,
EDINBURGH,
December 16. 1823.

ESSAYS

ON

RAIL-ROADS.

CONTENTS OF ESSAYS ON RAIL-ROADS.

ESSAYS

ON

RAIL-ROADS,

PRESENTED TO THE HIGHLAND SOCIETY.

(*Edited by* ROBERT STEVENSON, *Esq. Civil Engineer.*)

AT the original institution of the Highland Society of Scotland, in the year 1784, one of its chief objects is declared to be, the facilitating of communication, by means of roads and bridges. The influence, therefore, of an association comprising so large a proportion of the nobility and landed interest of the kingdom, must necessarily have had an important effect in directing the public attention to an object of so much general utility as that of rendering all parts of the country easily accessible.

Accordingly we find, that, previous to the period at which this Society was instituted, our public roads were extremely defective both in their lines of direction and draught; and the greater part of the Highlands was, till then, literally shut up and inaccessible to carriages of any description. Perhaps the first great step towards improvement in road-

making, upon scientific principles, in any part of the United Kingdom, was the formation of the Military Roads of the Highlands, soon after the unfortunate troubles of 1745. But even these, agreeably to the practice of the times, were too often carried by the most direct line, without due regard being paid to avoid the undulations of the country. So much was this the case, that a celebrated traveller, when asked, at one of the most difficult passes on these new highways, what could induce the fabricators of such a road to insert their names upon certain stones set up by its side? "I know not," he facetiously answered, "unless it were to afford the weary traveller an opportunity of cursing them by name and surname." In this state, the roads of the North were occasionally found, and thus they remained for many years; with the example, it must be confessed, of too many of the beaten paths of the South. Though it is not here meant to be inferred, that the late improvements were wholly in consequence of the immediate exertions of the Highland Society; yet such a concentration of influence as this great body possesses, exerted in all the walks of life, cannot fail to be regarded as one of the principal causes of that excellent system of roads which is now in operation.

The Government having, with the most enlightened policy, advanced one-half of the necessary funds for opening roads in the north of Scotland, while the landed proprietors contributed the other,—by this happy union of objects and interests, together with the open and unenclosed state of the country,

the hands of the engineer have perhaps been less hampered in this than in any other district of the kingdom. Hence it is that the highways of the North are extremely well laid out; and, metal being every where abundant, no country can boast of better roads, either in regard to their line of draught or general fabric.

The wealth of England enables her to stand unrivalled in the formation of her Water-ways, or numerous Canals. By these the horse-load has been much extended, and the conveyance of merchandise greatly facilitated. In Scotland and Wales, her less wealthy neighbours have endeavoured to supply this want, by the construction of numerous Rail-ways, which are perhaps better adapted than canals to the undulating surface of their respective countries; while they are more economical and more generally applicable to the ordinary purposes of commercial traffic.

This branch of internal improvement has accordingly been by no means overlooked by the Highland Society. In the year 1818, the attention of scientific and practical men was directed towards it, by an offer of a reward for the advancement of the Railway-system, in terms of the following advertisement:—"A piece of Plate, of Fifty Guineas value, will be given for the best and approved Essay on the construction of Rail-roads for the conveyance of ordinary commodities. In this Essay, it will be essential to keep in view how far rail-roads can be adapted for common use in a country,—the means of laden-carriages surmounting the elevations

occurring in their course,—and whether rail-roads, or the wheels of carriages, may be so constructed as to be applicable to ordinary roads, as well as to rail-roads; so that no inconveniency shall be experienced on leaving either to travel on the other. The Essay to be accompanied with such Models or Drawings as shall be sufficient to illustrate the statements it contains. It is further desirable, that some account should be given of the principal Rail-roads in Britain, together with a brief history of their introduction. The premium is not to be decided until the 10th day of November 1819."

In consequence of this advertisement, a variety of Essays and Models were presented to the Society; but none of them having been considered as coming up, in all respects, to its views, the value of the piece of plate was directed to be divided among the several candidates. The Society, aware of the national importance of the subject, again gave notice of a new Premium, of equal amount, for the same object. Still, however, none of the second set of Essays were considered complete. Some contained a historical account of the existing Rail-ways, without bringing forward any thing new, or practically useful, for overcoming the inequalities of the road, so as to keep its intermediate compartments upon a level. The writers of other essays directing their attention, with various success, to this last object, overlooked the other points contained in the notice. The Directors, therefore, found it advisable again to divide the premium among

the several candidates. But the Society, anxious to preserve all the useful hints given, and also the models produced, have devoted to this object a sum considerably exceeding the premiums offered. It was also resolved, that the several Essays should be put into the hands of a professional person, who should either give these communications entire, or such an analysis of them as may convey to the public the more essential parts of the information thus obtained, together with such remarks of his own as he might judge useful.

The editor of this article having accordingly been applied to, he selects the following Historical Account of Rail-roads, with certain modes suggested for elevating loads from one level to another, from the several Essays put into his hands; and begins with that of ALEXANDER SCOTT of Ormiston, who seems to have bestowed much attention on the subject.

MR SCOTT'S ACCOUNT OF RAILWAYS.

It appears that waggon-ways were not in use, in the neighbourhood of Newcastle-upon-Tyne, in the year 1600; for, among other regulations made in that year, " at a Courte of the Hostmen's Company, the wains were ordered to be all measured and marked;" for it appeared, " that, from tyme out of mynd yt hath been accustomed that all cole waynes did

usuallie cary and bring eighte boulls of coles to all the staythes upon the river Tyne;" but, of late, several had brought only, or scarce, seven bolls. The same record mentions "two small maunds or pannyers holdinge two or three pecks a-piece." From which passages, it plainly appears that coals at this time were not only brought in carts along the ordinary roads, but that a practice then prevailed of conveying them on horse-back.

"A Mr Beaumont, from the south, a gentleman of great ingenuity and rare parts, adventured into our mines, who brought with him many rare engines; among the rest, he introduced into the coal-trade waggons with one horse to carry down coales from the pits to the staiths of the river *."

Lord Keeper Guildford, in 1676, thus describes the waggons and rail-ways.—'The manner of the carriage is by laying rails of timber from the colliery to the river, exactly straight and parallel; and bulky carts are made with four rowlers fitting these rails, whereby the carriage is so easy that one horse will draw down four or five chaldron of coals, and is an immense benefit to the coal-merchants." Mr Hutchison, in his History of Durham, says, that waggon-ways were first made and used in this county, by Colonel Liddell of Ravensworth; but, upon examining the books at Ravensworth Castle, "Mr Robson (the present agent) informs me," says Bailey, in his Survey of Durham, p. 35., "That

* Harleian Miscel. xi. p. 263,-264.

the first staith-bills are in 1671, in the time of Sir Thomas Liddell, Colonel Liddell's grandfather, and seven years before the Colonel was born. Joshua French was then staithman; and from his bills beginning with that year, it appears that coals were then led by waggons to Teamstaith."

With regard to the introduction of cast-iron railways, a late anonymous author (1821) says, without advancing his authority, " that, in 1738, cast-iron rails were first substituted for wooden ones; but, owing to the old waggons continuing to be employed, which were of too much weight for the cast-iron, they did not completely succeed in the first attempt. However, about 1768, a simple contrivance was attempted, which was, to make a number of smaller waggons, and link them together; and, by thus diffusing the weight of one large waggon into many, the principal cause of the failure in the first instance was removed, because the weight was more divided upon the iron."

The method of bringing coals from the wall-face to the pit-bottom, was greatly improved by the introduction of cast-iron rail-roads below ground, in place of wooden ones. For this improvement, the mining interest is indebted to Mr John Curr, who introduced them, about the year 1776, into his Grace the Duke of Norfolk's works, near Sheffield. It is also further indebted to the same gentleman for the introduction of the flat rope, which is, without doubt, the best of any yet invented, for drawing coals, and working certain kinds ofm achinery, and

has proved an immense saving, compared with round ropes. Flat ropes are generally made of four ropes, laid together horizontally, being alternately right and left laid ropes, connected with small ropes by the aid of machinery; and, by this very ingenious plan, they counteract each other in the twist. The inventor has secured the application of these ropes, by letters-patent, dated 29th June 1813.

The wooden railways of the present day are generally formed in this manner:—Pieces of timber (called sleepers), about 6 feet long, and 6 inches square, are laid across the road, at the distance of from 18 to 24 inches from each other; and, upon these sleepers, other pieces of timber, called rails, of 4 or 5 inches square, are laid in two parallel lines, 4 feet distant from each other. The waggon-wheels are constructed with a groove to correspond with the rails, and thus run with little friction. The friction is also, in some instances, materially lessened by covering the wooden rails with malleable or cast iron. The cast-iron tracks of the earlier railways were made flat, of about 4 inches in breadth on the tread, with a projecting ridge (to keep the wheels within the track) and of a thickness suitable to the weight they had to carry.

The railway between Kilmarnock and Troon harbour is laid with flat or Plate-rails of three feet in length and about 40 lb. in weight each; their horizontal base on which the carriage-wheels run is 4 inches in breadth; and the ledge or flange rising perpendicular in the inner side of the rail, is about 4

inches in height, raised in the centre, and declining at both ends of each rail, to add to its strength. The rails are somewhat broader at both ends, to make them lie more solid on the blocks; they are not laid on sleepers of wood, but on solid blocks of stone, from 9 to 12 inches in thickness, and generally more than a foot square in base and surface. The ground upon which these blocks are laid is beat solid, and the stones are also beat down after being laid, so as to give them all the solidity possible. The iron-rails are bedded level on the blocks, and a hole about an inch and quarter diameter in the centre of each block, six inches deep, is filled with a plug of oak; and a square notch being formed in the centre, at both ends of each of the rails, about half an inch on each side above, and somewhat narrower below, when the ends of two of these rails are put together, the notches in each form one hole about an inch in length, and more than half an inch in breadth, contracting a little below. These being placed over the plug of wood, in the centre of the block of stone, a nail is driven into it, the head of which exactly fills up the hole in the ends of the two rails; the holes and heads of the nails being counter-sunk or broader above than below, are intended to keep the rails solid and firm on their beds. The space or horse-track between the rails is 4 feet, filled with road-metal up to the sole of the rails; but, on the outside, it is nearly to the top of the flanges. This is a double railway; and the distance between the two rail-roads or courses being

the same as the width of each, a horse may travel in the middle space with a wheel on the inner range of each of the roads.

Other methods of fixing down flat rails for carriages on rail-roads, are in use. One, in particular, was proposed to the Society for the Encouragement of Arts, &c. by Charles Le Caann of Llanelly, in Wales, for which he received a reward of 20 guineas, 12th May 1806.

The rail now generally introduced is called the Edge-Rail, and consists of a bar of cast-iron of about 1½ inch in breadth for the seat of the wheel, of from 3 to 4 feet in length, and of a depth corresponding to the weight to be carried. These bars are set upon edge, instead of being laid flat, and are, therefore, much stronger, weight for weight, than the flat laid bars. In a few instances, rail-road-bars have been made of malleable iron, and are said to be preferable to those of cast iron. It may be noticed, that a double railway will occupy about 20 feet, and a single railway 12 feet; but some of the English double railways are allowed, by act of Parliament, to occupy 21 feet in breadth.

In England railways are very often made to connect or branch off from navigable rivers and canals. The Surrey railway commences on the south bank of the river Thames, near Wandsworth, and proceeds south-east, about 10 miles, to Croydon, and then in a more southerly direction 16 miles to Godstow; it is a double railway, the inclination nowhere exceeds 1 in 120, or 1 inch in 10 feet. Nu-

merous canals and railways branch off from the river Severn. A rail-road has been constructed five miles from the harbour of Portreth to the mines near Redruth. From the harbour of Lanelly, on the Burry river, the Caermarthenshire railway extends 15 miles, through a productive coal-country, to the lime-works near Laudebie; and on the eastern side are railways to the extensive coal-works of General Wade. Several railways communicate with the Swansea Canal, and the coal-works on the other side of the valley. The Oystermouth railway proceeds from Swansea, seven miles along the coast, south-west to the village of Oystermouth, chiefly for the carriage of lime. Various railways branch off from the Neath Canal to the neighbouring collieries. The Cardiff and Merthyr-Tydvil railway, is 26$\frac{3}{4}$ miles long, running near the Glamorganshire Canal: at Quaker's Yard, a branch of 9$\frac{5}{8}$ miles goes off to Carnomill. These railways are carried through a very rugged country.

The Monmouth Canal divides into two branches; the one follows the channel of the Ebbw river, 11 miles to Crumlin Bridge, whence lines of railways proceed up the Ebbw 21 miles, to Ebbw Vale and Beaufort Iron-works, with branches to Sirhowy, &c. and also up the Ebbwvach to Nant-y-Glo Iron-works. The eastern or main line, is from the Uske to Pont Newydd, near Pontypool, 12$\frac{1}{2}$ miles, rising 447 feet, whence a railway proceeds 5$\frac{1}{2}$ miles, rising 610 feet, to Blæn-avon furnace. Various other branches of railways are con-

nected with this navigation; but the most important is the Sirhowy line. This railway commences at the Monmouth Canal, Pillgwelly, and passing through Tredegar Park up the Ebwy river at Risca, crosses that river by a bridge of 16 arches, following afterwards the course of the Sirhowy river by Tredegar and Sirhowy Iron-works to Trwell Lime-works, about 28 miles. A branch proceeds to Romney Ironworks, and from the same place the Brenore railway is continued over the Black Mountain to the vale of the Uske at Brecon; and from thence to Ilay on the Wye, by means of which, the price of coals in the upper parts of the counties of Hereford and Radnor, has been greatly reduced. The Sirhowy railway is accompanied through all its extent by a good turnpike road. There are also branches from the railway to the several collieries, and likewise to the Monmouthshire Canal in two places.

From the Brecknock Canal a railway passes by a bridge over the Uske to Abergavenny. There is a railway to Uske, and various others to the coal and iron-works. From the Wye near Mitchel Dean, a railway has been laid through the forest of Dean to Lydeny on the Severn, opposite Berkely, and another branch from this by Colford to Monmouth; and nearly opposite to the Stroud Canal, a third railway has been made 5 miles to the collieries in the forest.

Near Ponteysylte, on the north bank of the river Dee, a double railway ascends gently past Mr Hazledene's ironworks, and through numerous collieries to

Ruabon Brook, a distance of about 3 miles. From the Peake.Forest Canal, a railway proceeds 6 miles, from Chapel-Milton to Loads Knowl Lime-quarries.

At Wakefield the Calder and Hebble connect with the Barnsley Canal, and there are many railway branches to coal-works. From the Cromford Canal, there are one canal-branch, and two railways to the several adjacent works, which export coal, lime, lead; and import general merchandise. There is a railway-branch from Erewash Canal to Brunsby Coal-works. There are railways from the Derby Canal, to Horseley Collieries, to Smithy Houses near Derby 4 miles, and to Smolly Mills 1½ miles. The River Soar is connected with the Leicester navigation, and also the Charnwood Forest Railway, which proceeds westward 2½ miles, with a rise of 185 feet to the Forest lime Basin, and here the Charnwood Forest water level of 8¾ miles commences. There are branches of railways to the Lime-works of Coal Orton, Barrowhill and Cloudshill; also to Swannington Collieries. From the Cloudshill lime-works, the railway is continued 6½ miles to the Ashby de la Zouch Canal. From Stoke, near Newcastle-under-Line, there is a railway to Lane's End 3 miles. From Etruria, there is a railway to Hornby Green and Burslem Potteries. From Longport to Dolehall, there is a canal branch, and thence a railway, to Burslem Potteries; and a railway from Troghall 3 miles, which ascends to the Caldonlow Lime-works, and another 5 miles to Measham Collieries.

In the county of Lancaster, there are a great many iron-railways for the convenience, accommodation and advantage of the different collieries, manufactories and other works. The coal-works near St Helen's in the vicinity of Liverpool, have a double railway, some miles in length; and at the works of Lord Balcarras, near Wigan, as well as his canal coal-pits near the same place, there are double railways of very considerable length. To the south of the town of Preston there is a double railway, and of great length. There are several railways from Whitehaven harbour to the famous coal-mines in its vicinity, where it is said that 100 horses are constantly employed below ground.

With regard to the great coal counties of Northumberland and Durham, Akenhead's map of the numerous coal-mines, on the Rivers Tyne and Wear, whereon the waggon-ways from the Collieries to the Staiths on each river are represented by dotted lines, will convey a more distinct and perfect idea of the number and extent of these, than any account or description that can be given of them.

In Scotland, railways are also employed for the conveyance of goods at all the collieries, and other works of any extent. Perhaps the only public road of this description is that from the Troon to Kilmarnock, which, though the property of His Grace the Duke of Portland, is open to carriers on paying a certain toll, which is regulated by the act for that work. This railway has a double set of tracks, as before noticed, and is 10 miles in length. The total rise from

Troon harbour to the town of Kilmarnock is from 80 to 84 feet. This railway crosses the Irvine, near Milton, by a bridge of four arches, of 40 feet of span, and rising 25 feet above the surface of the river. It passes for about a mile through Shaulton Moss, which in some places is between 30 and 40 feet in depth, and is extremely soft. The greater part of the two miles towards the harbour has been raised by embankments, in some places 10 or 12 feet in height.

The other railways in Scotland, which may be mentioned as of any extent, are those at the works of the Carron Company; Shotts Iron Company; of Lord Elgin; Mr Erskine of Mar; Sir John Hope of Pinkie; Mr Cadell of Cockenzie; Mr Wauchope of Edmondston; Mr Dickson and others, in Lanarkshire; and Mr Taylor and others in Ayrshire. Of these, the plate-rail is in use at the Troon road, but the edge-rail is more general, and is now often made of malleable iron.

MR SCOTT'S ACCOUNT OF INCLINED PLANES.

We are now to notice the principal Inclined Planes which have been constructed for conveying waggons or boats on carriages from one level to another. For this application of the railway, we are said to have been indebted to a Mr Davis Dukart, an Engineer in the Sardinian Service, who first introduced inclined planes into the British Dominions.

He resided some years in Ireland previous to 1777, and was engaged in the Tyrone Collieries. He constructed three inclined planes; the falls were 70, 65, and 55 feet.

The Duke of Bridgewater's underground inclined plane at Walkden Moor, in Lancashire, is perhaps one of the most remarkable works of this description. It has a run of 151 yards, besides the length of the locks at the upper end, which are 18 yards. The declivity is one in four, corresponding with the dip of the rock, from which it is completely excavated. About 94 yards of this railway are formed into a double waggon-way, in order to let the empty and the loaded boats pass up and down. The two ways are divided by a brick-wall, which also supports the roof. In this wall there are openings formed for a person to escape out of the way of the boats, in case of accident to the machinery. This double waggon-way joins in one about 57 yards from the lower level. The whole width of the double waggon-way is 19 feet; and of the single one 10 feet, after their junction. These waggon-ways are laid with iron-rails on sleepers down the whole run; and the height of the roof above the iron-rails is 8 feet. At the top of the inclined plane, there is a double lock, or rather two locks, side by side, formed also in the rock, which lay the loaded boats from the higher level of the canal on the inclined plane, and receive the empty boats from the lower canal. The length of that part of the tunnel in which these are formed, as before noticed, is 13 yards, the width, or

diameter, 20 feet 6 inches; and the height of the roof above the locks 21 feet, to admit of a large brake-wheel, used for lowering the boats.

The bottom or lower end of the inclined plane is 6 feet 9 inches under the surface of the water, where the loaded boats float off the carriage upon the canal of the lower level. The depth of the locks, under the bottom-level of the water of the canal, at the upper end of the inclined plane, is 4 feet 6 inches, and at the lower end it is 8 feet. The wall between the locks is 9 inches above the surface of the level water, and its breadth is 3 feet.

The diameter of the horizontal main shaft upon which the rope works, to let the loaded boats down the inclined plane, and draw the empty boats up, is 4 feet 11 inches, and its circumference is 15 feet 5 inches; the main rope is 2½ inches in diameter, and 7½ inches in circumference. It is wrapped round with a small cord of about an inch in circumference, for the length of about 105 yards, to prevent its wearing, which it does chiefly when it drags at the place where the waggon-ways unite; to avoid this, rollers of 8 inches diameter are fixed at intervals down the run of the inclined plane. Moreover, a hollow cast-iron roller of 8 inches diameter, is fixed across the west lock, parallel to the upper west gate, and near the west end of the lock, but half a yard higher than the gate, in order to bear up the rope, and to prevent it from swagging. A holdfast rope is fastened to the main rope, to stay each boat upon its waggon as it goes up or down. Upon the hori-

zontal main shaft is the brake-wheel above mentioned, which regulates the motion of the loaded boat going down the inclined plane.

The number of teeth in the spur-wheel, which is fastened to the side of the brake-wheel, is 372, and the pinion which sets it in motion contains 11 teeth. The pinion is supported by two uprights from the pillar to the roof, and works between them. Two winches, or handles, in its axis, put the main shaft in motion. The spur and brake-wheels are fixed near the middle of the horizontal main shaft, in order that the rope of the ascending boat may coil upon the one end of the shaft, and the rope of the descending on the other. The power of the wheels and handles united, enables a man, who uses a force equal to 40 lb. weight, to set forward two tons upon the waggon-road; and this force may be used to set forward the loaded boat out of one lock, and to bring the empty boat into the other. The boats being thus put in motion, the pinion is disengaged from the spur-wheel, by a slide drawing it sideways. The weight of four tons going down brings up about one.

The spur-wheel is seldom used, except for stretching the ropes, or when the boat is overloaded.

The length of the carriage or cradle, for the boat, is 30 feet, its width is 7 feet; it moves upon four solid cast-iron rollers, which run upon cast-iron plates; on one side of each of which there are iron crests or flanges, which stand 2 inches higher than the plates, and prevent the carriage from running off the road.

The weight of the nett coal contained in the loaded boat is about 12 tons; the boat weighs about 4 tons; and the carriage or cradle, in which it is placed, when conveyed down the inclined plane, is about 5 tons, in all about 21 tons.

Where the Aberdare branch of the Glamorganshire Canal terminates, railways commence, passing the iron-works of Abernant, Aberdare and Hirwain, and thence to the summit of a precipice, near Neath Valley, where an immense inclined plane completes the communication with the Neath Canal. Up this inclined plane the waggons are dragged by a high-pressure engine of Mr Trevithick's construction.

At the iron-works near Pontypool, there are some lofty inclined planes. From Stourport upwards of 25 miles to Coalport, the course of the Severn is generally bounded by high steep banks, and the country on each side is hilly, so that no collateral navigation occurs in that distance; Coalport is the lower termination of the Shropshire Canal. This work forms a singular epoch in the history of English canals; for the country over which it passes being extremely rugged and abrupt, and there being likewise a scarcity of water, the modes formerly practised were quite inapplicable. These difficulties suggested the adoption of a plan, then lately introduced into that country by Mr William Reynolds at Ketley Iron-works, which consisted in forming canals upon different levels, terminating at steep banks, and conveying the boats between them by means of in-

clined planes, constructed upon the slope of the above mentioned banks.

In pursuance of this new mode, the commencement of the Shropshire Canal is formed by a cut of about three quarters of a mile in length, along the east bank of the Severn, just above the reach of the floods, and leaving room to stack the coals between it and the river. From this level, up the face of a steep bank, an inclined plane is constructed of 350 yards in length, and 207 feet perpendicular height, with a strong double rail-road upon it, to admit boats loaded with 5 tons, and their carriages. From the top of the inclined plane, a level canal is made 1¾ miles to the bottom of the second or wind-mill inclined plane: This is 680 yards in length, and 126 feet in height. From the top of this to the top of the Rodwardine Wood inclined plane, a distance of 5 miles, is the summit level; this last mentioned plane is 320 yards in length, and 120 feet fall; beyond this the canal extends 100 yards, which is level. At Southhall Bank three quarters of a mile from the top of the wind-mill inclined plane, a branch of 2¾ miles passes westward to Briarly Hill, where formerly there was a communication with the Coalbrookdale works, on a much lower level, by means of crates or boxes, descending through successive pits; but in preference to that mode inclined planes are now employed.

About 1¼ miles from the top of the Rodwardine Wood inclined plane, a small canal branches off to the Ketley Iron-works, and it was here that Mr

Reynolds, in the year 1788, constructed the first inclined plane with a fall of 73 feet for 8 ton boats. The chief purposes of the Shropshire Canal, are the exportation of iron and coal from the adjacent works, and the importation of limestone for the blast furnaces. From the bottom of the Rodwardine Wood inclined plane, a canal of 7 miles has been constructed by the Marquis of Stafford, to Pave Lane, near Newport, with a branch on a higher level to his lime-works at Lillieshall, which formerly communicated with the main line by pits, but now by an inclined plane.

A little below Northwick is a communication with the Grand Trunk Canal, by inclined planes. The slate-quarries above Bangor and Carnarvon, situate on the Menai Strait, have iron rail-roads, with several inclined planes. The Peake Canal, being through a rugged country, has some very expensive works; one an aqueduct of three 60-feet arches, each about 100 feet high; and an inclined plane of 515 yards in length, and 204 feet fall. On the line of the Lancaster Canal, a fall of 222 feet is passed by a railway and inclined plane, on each side of the Valley of the Ribble. The White-house inclined plane, on the Urpeth waggon-way, is 1600 yards in length; from 6 to 9 laden waggons bring up as many empty ones. At Sunderland, the sea-vessels pass under the great iron-bridge over the river Wear, which is 236 feet span, and 100 feet high. On the south side of the river, a short distance above the bridge, a steep ravine branches to-

wards the south-east; on one side of the ravine, a series of warehouses have been erected, in which large quantities of coal are deposited, and from them a waggon-way is erected, supported on long wooden pillars, which descends at an angle of about 30 degrees, through an arch cut in the opposite rocks, and then continues to run on a level but elevated platform along the side of the river. This waggon-way is so constructed, that when a waggon, loaded with coals, descends on one side, it pulls an empty waggon up on the other. The ship to be loaded is placed immediately under the elevated platform, when a trap-door is opened, and the bottom of the waggon being let down, the coals descend through a trough into the ship; in some cases, the waggons themselves are lowered altogether, by machinery, from the platform.

The railway, on Lord Elgin's works, between Dunfermline and Limekilns in Fife, for design and execution, is inferior to none. On this line of railway there are two inclined planes, executed with all the requisite machinery, for the loaded waggons drawing up the empty ones; the longest of these is about 511 yards, with a declivity of about one in twenty. Between the two inclined planes, the ground had been originally nearly level to some extent: an ingenious advantage is taken of this level, by commencing, at a short distance from the foot of the upper inclined plane, and cutting out a track for a railway, with an easy slope in the line of the main descending railway for the loaded waggons, by banking

up the earth, and facing it with a stone-wall; another railway is formed with a similar slope, but in a contrary direction, towards the foot of the upper inclined plane. In this manner the two railways are carried forward, until they reach the top or bank-head of the under inclined plane, where the difference of perpendicular height between the two appears to be about 10 feet; the one-half of this height gives a declivity to the loaded waggons to proceed downwards; and the other half a declivity to the empty waggons, to proceed to the foot of the upper inclined plane: the brake or drag of the loaded waggons has only to be attended to, for regulating their motion to the place where they start upon the inclined plane. By forming two railways upon the original level line, in the manner above described, the bank-head of the empty waggons is several yards from the bank-head where the loaded waggons start: this distance is got the better of, by means of an additional piece of rope or chain, that is hooked off and on, as occasion requires. The breadth of each set of tracks on this railway is 4 feet 3 inches; the weight of each of the waggons, when loaded, is between 2 and 3 tons. From 100 to 200 tons of coal pass down this railway daily.

Mr Cadell's waggons travel from his coal-works, in Tranent Moor, to Cockenzie, a distance of upwards of 4480 yards, on a cast-iron railway, that has various declivities and circular turns; and require only the assistance of a man, in the downward journey, to attend to the several brakes attached to the

waggons. The breadth of the horse-track is 3 feet 3 inches; the waggons, when loaded, including their carriages, are each about 2 tons. A horse sometimes takes up 5 empty waggons, but the common number is 4, and these he generally drags three times a-day.

Of the methods at present employed for surmounting the elevations on rail-roads, it may be noticed in general, that they have only been adopted in situations nearly level, or where the loaded waggons have declivities to descend.

Among the various methods that have been put in practice, for dragging waggons and boats, on ascending railways, conducting them down declivities, or along level planes, the patent Locomotive Engine of Mr Stephenson of Newcastle may be noticed, by which 50 tons of coal, and upwards, are at one load conveyed several miles along a railway, by the force of steam. The town of Leeds is also regularly supplied with coals from pits several miles distant, by the means of steam-engines, without having recourse to horse-power.

On the 21st February 1804, a trial was made on the Cardiff and Merthyr railway, with one of Trevithick's high-pressure steam-engines for drawing waggons, when 10 tons of iron, and 70 persons, were carried 9 miles by the power of steam, without the use of condensing water. Steam-engines are frequently employed at the head of inclined planes, as the counterbalancing power for overcoming and regulating the ascent and descent of waggons

and boats, with their carriages. On the Shropshire Canal, already noticed, there are three inclined planes, of 120, 126 and 207 feet of rise. At the head of each of these, a small steam-engine is used for working the axis of the rope-barrel, at some distance from which, on the upper side, there is a pulley or wheel, fixed at a proper height, for the rope to pass over, in drawing the boats up, or letting them down, the descending plane; another smaller axis and rope-barrel is provided, which, like the larger one, can be cast in or out of the engine-gear at pleasure: this last is used for hauling the boats up the short ascending plane, from the upper canal. The engine can also be used to draw empty boats occasionally up the long plane, in case such require to pass when there are no loaded ones ready to descend.

An inclined plane is sometimes made for the purpose of carrying a counter weight, or vessel full of water, whose rope passes over another axis, with a brake and hand-spoke wheel for hauling the boats on their carriages out of the upper level to the ridge, or to ease them down into the same. Steam-engines are placed at the top of most of the Newcastle inclined planes, to pull up and let down their coal-waggons. Mr Barnes's inclined plane is about 864 yards in length, which distance the waggons descend in two minutes and a half, and the empty waggons return after discharging their cargoes in seven minutes; the impelling or retarding motion is derived from a plummet of 16½ cwt., which the waggons in descending and ascending al-

ternately raise or lower to the depth of 144 yards. The rope by which the waggon is impelled and accelerated, winds round the axis of a large wheel in a notch or groove in the middle, which gives the rope only space to coil round upon itself, and therefore guards against all possibility of entanglement. Near to the axis of the large coiling wheel, there is an oblique indentation with a range of teeth or cogs of cast-iron, which corresponds with, and works into, a similar conformation on the rim of a smaller wheel, round which the plummet-rope is coiled, and it is in consequence thereof moved round only once in six rotations of the suspending and retracting wheel, which is the same proportion that the elevation of the plummet weight bears to the descent of the waggon. The coiling wheel of the waggons must either be, in the present case, six times the diameter of the coiling wheel of the plummet, or else the toothed wheel that is fixed upon the axis of the coiling wheel of the plummet, must contain six times the number of teeth to that of the toothed wheel that is fixed upon the axis of the coiling wheel of the waggons, so as to answer the proportion that the length of the inclined plane bears to the deepness of the plummet pit, when both coiling wheels are of the same diameter.

To preserve the rope from injury by dragging on the ground, rollers with iron-pivots and brass-sockets for it to run upon, are elevated in the middle of the railway, but sufficiently low to prove no obstruction to the waggons which pass over them.

At the head of shorter inclined planes, horse-gins, as also water-wheels, where there is a command of water, are employed for pulling up and letting down waggons, on inclined railways; and where the inclined planes are very short, the ascent and descent of waggons, or boats on them, are sometimes overcome by manual exertions, with the aid of capstans. Rail-roads, not unfrequently in the course of their length, are laid out with various acclivities; which are overcome by having in readiness an additional horse to put to the waggons as they arrive at the bottom of the acclivities.

Where the loaded waggons are employed to draw up the empty ones, two large coiling cylinders are erected at the top of an inclined plane, with double railways in strong frame work, and are so fitted up that they will either act as if upon one axis, or separately, by means of a coupling-box. At the outer end of one of these cylinders, there is generally a large cast-iron toothed wheel, fixed on the same axis, which can be put in motion by means of a pinion of the same metal, when necessary, for adjusting the ropes or the like: when not wanted, the teeth of the pinion are drawn out of those of the wheel, by sliding it outwards. On the outer end of the other cylinder is a clasp or vertical brake-wheel, fixed on the same axis.

The coiling cylinders have separate ropes, and each of them is some yards longer than the inclined plane. Let it be supposed that the rope of the loaded waggons is all coiled upon its cylinder, and

the rope of the other cylinder that belongs to the empty waggons uncoiled, and stretched down its railway, and resting upon the different rollers placed in the middle. Before the end of the rope is hooked to the loaded waggons, a skeleton waggon is attached to the train, of sufficient weight to keep the rope tight in bringing it up, when again to be coiled upon its cylinder. There is also a half skeleton waggon to be annexed to the train of empty waggons, loaded with pieces of cast-metal, of a sufficient weight not only to work up the return rope of the loaded waggons, but also the skeleton waggon that went down with them. Now, supposing every thing arranged in the manner described, and the empty waggons at the foot of the plane hooked to their rope, with a half skeleton waggon annexed, and the rope of the loaded waggons hooked to the skeleton waggon, then may they be allowed to proceed down the plane; and they will move quicker or slower, as to the man at the brake may seem fit, until they reach the foot of the plane; by which means the rope of the empty waggons will be coiled upon its own cylinder, and, at the same time, it will bring them up to the head of the plane. After sufficient time is allowed to remove the loaded waggons from the foot of the inclined plane, leaving only the skeleton waggon hooked to the end of the rope, as also removing the empty waggons at the top of the plane out of the way, except the half skeleton waggon, the next step is, to dispatch it down the railway, when it will bring up the skeleton waggon, and again coil the rope of the loaded wag-

gons upon its cylinder, as at first; when the whole will again be in readiness for another gang or train of loaded waggons, as also for the empty ones, the end of their rope being in this state of things again at the foot of the plane.

There is another method by which the descending loaded waggons are made to pull up the empty ones upon an inclined plane with double railways, where horizontal coiling cylinders are employed, which is, by continually shifting the train of waggons at the head and foot of the inclined plane, from the one railway to the other; so that the loaded waggons shall always pass down the railway that the empty ones came up. By this arrangement, the ropes are coiled off and on the cylinders, without the aid of the skeleton waggons mentioned in the last method.

Descending loaded waggons are also made to pull empty ones up inclined planes with double railways, by means of a vertical drum or cylinder, that has a horizontal groove, with projecting ledges made round it, of a sufficient breadth and depth to receive two or three coils of the rope of the waggons. Immediately below this cylinder, a horizontal brake-wheel is fixed. If the one end of the waggon-rope, after being coiled twice round the cylinder, be hooked to the loaded waggons supposed to be at the top of the plane, and the other end hooked to the empty waggons at the bottom of it, (the rope being of a suitable length for the inclined plane, and convoy pulleys being placed so as to

guide the rope into the groove of the cylinder, direct in the lines of the two railways), and the loaded waggons be allowed to proceed on the inclined plane, their superior weight will bring up the empty ones to the head of it, the brake-wheel revolving quicker or slower, at the pleasure of the man that has the charge of its motion. On the empty waggons being removed out of the way, and another gang of loaded ones brought forward to the head of the railway, by which the empty ones were brought up, and that end of the rope hooked to the loaded waggons, the other end of it at the foot of the other railway being hooked to a gang of empty waggons, supposed to be there in readiness; and the loaded waggons being allowed to proceed down the inclined plane, they will bring up the empty ones as before, but on the other railway; and so on alternately.

Instead of ropes, iron-chains are often used for loaded waggons to draw up empty ones; and the same kind of brake-wheel is used here as with ropes, except that, in place of a cylinder above the brake, there is a horizontal groove on the upper half of the brake-wheel.

In passing down descents, what are called Sledges or Slippers, made of cast or wrought iron, are sometimes used, which are placed under the wheels of one or more of a gang of waggons, to prevent their too rapid descent. They are similar in principle to the same kind of instrument made use of for putting under the wheels of common carriages on going down hill. Simple as the common rail-waggon convoy may

appear, yet it was not till of late years that it was made to act upon more than one wheel.

Methods proposed by Mr Scott *for overcoming Ascents on Rail-roads.*

The following is a proposal for enabling a single horse to work a *gang* or train of waggons up an inclined railway. A railway is to be formed from top to bottom of the inclined plane, protected in a manner similar to those laid across streets or public roads; with this difference, that the top of the inner railway on each side of the road is to be formed with teeth similar to those of a strong rack. Agreeably to the drawings of this scheme presented to the Society (by Mr Scott,) a waggon is to be so constructed, and of such a length, as not only to admit two pairs of waggon-wheels, of about 28 inches in diameter, but also a pair of spur-wheels between them, of about 30 inches diameter, with 60 teeth. These two spur-wheels are to be placed on an axle exactly half-way between the two pairs of waggon-wheels; and they are to be fixed on their axle, at a distance from each other corresponding to the distance between the rack-bars that are on each side of the road-way. The axle of the spur-wheels is to turn freely, in strong brass-bushes, without any side play. The teeth of these two spur-wheels are to work, at the same time, into the teeth of the rack-bars, on each side of the road-way. Upon the middle of the axis of the spur-wheels, a screw-wheel is to be fixed, of about 24 inches in diameter,

with 48 teeth; a screw of a single thread is to work into the teeth of the last mentioned wheel. On the axis of this screw a wheel is to be fixed, which is also a screw-wheel of about 20 inches diameter, with 40 teeth; a screw of a single thread is, in like manner, to work into this last mentioned wheel. On each end of the axis of this screw is to be placed a bevel-wheel, with its face inwards, so as to face one another, and to be each about 18 inches in diameter, and to have each 36 teeth. These two wheels are not to be fixed on this axis, but are to be at liberty to play freely against shoulders formed on the axis. Immediately on the outside of each of these two wheels, is to be fixed, on the same axis with them, a ratchet-wheel of about 13 inches diameter, with ratchet-catches, so placed on the outside of the bevel-wheels, that they will only admit the bevel-wheels to move the screw that forms a part of their axis round in one direction, and that alternately. Upon these two bevel-wheels, a third bevel-wheel, of about 36 inches diameter, and 72 teeth, is to be so placed as to act with its teeth, equally deep, into the teeth of the two smaller bevel-wheels. Upon the square top of the axis of the wheel of 36 inches, the thick end of the horse-lever is to be fitted. By giving this lever a backward and forward or traverse circular motion, equal to about five-sixths of the circumference of a circle, a continuous motion will be given to the two bevel-wheels and the screw that is upon the same axis, which may be called the first screw. This screw will communi-

cate a motion to the first screw-wheel: on its axis is the second screw, which will communicate a motion to the second screw-wheel: on the same axis with it are fixed the two rack-wheels, whose teeth will act on the teeth of the racks, and communicate a motion to the engine-waggon, and consequently to a gang of waggons, if chained to it.

The length of the lever, and the number of teeth in the wheel-work here proposed, are such as would act with great power, but the motion would be exceedingly slow. If ever such a machine should be brought into use, less or more power may easily be given to it, by altering the train of wheel-work, and length of the lever; as, for instance, if, in place of using the two single-threaded screws to work the screw-wheels, they be wrought by double threaded ones, this would lessen the power of the machine four times, and would cause the machine to travel four times faster, the horse travelling at the same rate in both cases: but, in place of endless screws, let pinions be applied; suppose two pinions, of ten teeth each, in place of the two endless screws, with single threads, then would the waggon move one hundred times as fast as with the single threaded screws, but with one hundred times less power, excepting the difference that arises between the friction of screws and that of wheels and pinions.

A machine of this kind might be applied with advantage, where there are very steep and short ascents from or to coal-works, limestone, freestone, and other

quarries. A waggon of this kind would have to be at all times considerably loaded, so as to keep the teeth of the wheels of the waggon into those of the racks. The whole machinery will require to be completely boxed in, so that the empty parts of the waggon may be employed to carry the same kind of loading as that of the other waggons in its train. A horse working in a traversing circular motion, will be able to continue much longer at work, than if he was to work one way round, in a continued circular course. In place of a rack on each side of the road-way, an open-toothed one may be laid up the middle of the road, but which would neither be better nor cheaper than the two side ones. Where expence is not so much regarded as the having every part fitted up in the most complete manner, a middle ratchet-bar may be introduced, in addition to the rack ones, and to the hind end of all the waggons, a stay-ratchet-bar-catch may be so hinged that its lower end shall fall into the teeth of the ratchet-bar, and a ratchet-pull hinged to the front of the waggon, to fall into the teeth of the same ratchet-bar, which would prevent the possibility of any accident arising from the teeth of the ratch-wheels being thrown out of the rack.

As the common break-wheels for regulating the descent of loaded waggons down inclined planes require a man's constant attendance to work them, a substitute is therefore proposed, that will require little or no attention, of which the following is a

description:—Wherever a break is found necessary, an oblong pit is to be sunk, and paved in the bottom on puddle, and built with hewn or aisler masonry on the sides and ends, and to be made water-tight by puddling the back of the building. This pit is to be filled, to a certain depth, with water, and a water-wheel is to be introduced into the pit: its gudgeons are to be supported on strong framed work in brass bushes. The axis of this water-wheel is to have three or more sets of arms morticed into it in the course of its length, and the wheel is to have eight or more arms in its circumference; the different sets of arms are to run in lines with the axis, so that each float-board shall rest on, and be nailed to, arms that form a straight line with the axis. The axis of this water-wheel is to be connected with coiling cylinders or grooved wheels, by means of suitable wheel-work, to answer to the power that the wheel is required to regulate. A wheel of this kind cannot be put in motion beyond a certain velocity, unless overloaded, and this it is easy to prevent, by ascertaining its powers experimentally. It ought, in the first place, to be as nearly regulated by the quantity of water in the pit, and by the wheel-work that connects it with the coiling cylinders or grooved wheels, as possible; and then it can be farther regulated, by having an adjoining water-tight pit near the wheel-pit, with a communication between them. Into this side-pit, let a water-tight plunger be introduced, of very little less diameter than the pit: this plunger

may easily be sunk or raised at pleasure, by means of a screw, or a rack and pinion with a winch, by which the water will be raised or lowered in the wheel-pit; and, in consequence thereof, will increase or diminish the resistance that the wheel will meet with when revolving. The plunger may be as much loaded as will require the same power to raise its bottom to the surface of the water, as it will take to sink it to the bottom of the pit. A wheel of this kind can be introduced where there is no running stream; the quantity of water required not being great, may be brought forward in barrels; the quantity that will evaporate will be trifling and easily supplied, in time of rains, as the evaporation does not take place in proportion to the quantity, but in proportion to the surface area, that is exposed to the atmosphere; and it may easily be so closed in as to prevent any inconvenience from frost. This simple brake may be applied to advantage in several situations besides the top of inclined planes, such as banks that are too steep for full loaded carts to pass down hill in safety with loads of stones, or the like; and where it is practicable for a single horse to take up an empty cart or light waggon to be loaded, or where the empty ones can be dragged up by one or more of the loaded ones.

Another method of overcoming ascents with loaded waggons, may be effected nearly upon the principle that canal-boats are raised or let down from one level to another, but upon a completely different

mode of application. If, for example, the acclivity be of considerable length and height, the first step is to begin at the bottom of the acclivity, and to cut a level road-way forward to the rise, of a convenient breadth for a railway, until the face of the cut be about eight feet in perpendicular height; and then commence again at the top of this face, and cut forward a road-way similar to the last, until the face of the cut be of similar height as before; and, in like manner, continue cutting successively level roadways, until you arrive at the top of the bank, or else to a height where it may be thought proper to strike off with a level railway. *Secondly*, To sink a pit not less than 16 feet deep, close to the bottom of each of these perpendicular faces. The sides and face of all these cuts are to be well built with hewn stones and lime; in like manner the pits are to be built on the sides, paved in the bottom, and made water-tight by puddling. Several upright beams of wood are to be built into the side-walls of the pit, so as only to appear in a line with the building: into the upright beams, several rollers are also to be introduced, with their axles at right angles to the length of the beams; these rollers are to project about an inch or so past the surface of the beams. The side-beams of the pit are to be of such a length as to reach to the top of the face-cut, and to be supplied with rollers above the pit, the same as within it. Upon the top of these beams, horizontal ones are to be strongly fixed parallel with the road-way; the use of which will be afterwards pointed out. A co-

vered water-tight caisson or chest, with two rails upon its cover, corresponding to those of the railway, is to be provided, equal in height to the depth of the pit, and of a breadth and length so as to move freely up and down against the rollers that are in the upright beams. If water be let into this pit, the dimensions of the caisson must be such as to give its buoyancy power by the time that the pit stands nearly brim-full, to carry any required weight upon its cover, to the height of the next rail-way-track. The strong horizontal beams already mentioned are to be so fixed as only to admit the caisson to rise to the exact height requisite to bring the rail-bars that are upon its cover into a line, and upon a level with those upon the upper railway.

Near to this which we term the caisson-pit, six smaller pits are to be sunk at least two feet deeper than it, and which are to be built on the sides, and flagged in the bottom, and made water-tight by puddling; these last are to have an open communication near their bottom with one another, as also with the caisson-pit. In each of the small pits there are to be upright posts built into the walls with rollers similar to those in the large pit; these beams are in like manner to reach a convenient height above the pits for fixing framed work. Into each a hollow water-tight plunger is to be introduced, equal in height to the depth of the respective pits; and its other dimensions are to be such as only to admit the plunger to move freely up and down against the rollers attached to the upright beams.

To regulate the dimensions of these pits with their plungers requires some calculations, not necessary at present to be entered upon, but which may be made from the following data:—When all the plungers are at the bottom of their respective pits, the water is to stand near to the brim of the caisson-pit, as has been already proposed. The six plungers ought to be made of such dimensions, that, on raising them up until their bottoms shall be upon a level with the surface of the water in the different pits, they shall cause the water to subside so much as to allow the caisson only to touch the bottom of its pit, when the least supposed weight is on its cover that it will be required to carry. To prevent the caisson from rising on removing this weight, several lever catch-bars are to be so placed as to keep the caisson upon a level with the lower railway; these catches are to be connected with a long lever, by the moving of which the caisson may either be kept down or left at liberty to rise.

A conspicuous mark is to be put on each of the plungers, to shew when their bottoms are in a line with the surface of the water, as mentioned in the last experiment, which, for distinction's sake, may be called the Centre Water-line. These six plungers are all to be made of different sizes, so that they may be forced down to the bottom of their respective pits by means of equal forces; and they are each to be so loaded with counter-weights, that each shall require the same quantity of power to bring their bottoms up to the centre water-line

again, that it required to take them down to the bottom of the pits. Let it now be supposed that the bottoms of all the plungers are upon a level with the surface of the water in the different pits, now to be understood as the centre water-line; then will the first or largest plunger have only to be forced down through the least depth of water, the sinking of which will occasion the water in all the pits to rise to a certain height; the second plunger will have a greater depth of water to be sunk through, and will therefore require to be of somewhat less dimensions, in order to be forced down by the same power that the first was; the third plunger will have still a greater depth of water to be sunk through than what the second had, and therefore must be made of still less dimensions than the second; and, for the same reason, the fourth will require to be made less than the third, and the fifth less than the fourth, as also the sixth less than the fifth. We are now to suppose the whole of the plungers at the bottom of their respective pits, and the top of the caisson upon a level with the upper railway, with the greatest load that it is required to ascend with. Let that load be moved away along the upper railway, and a similar descending load brought upon the top of the caisson; the first step to occasion the caisson to descend, is to draw up the first or largest plunger, until its bottom be in a line with what we have called the Centre Water-line of the pits. Although the bottom of this first and largest plungers now supposed to be brought upon

a level with what is called the centre water-line; yet it will appear evident, that its bottom will at present be considerably below the surface of the water in the pits, and therefore will admit of being loaded with a considerable counter-weight, so that it may require as much power to raise it to the centre water-line, when at the bottom of the pit, as to sink it down from the centre water-line to the bottom of its pit, and consequently will admit of being made of the larger dimensions. The second plunger will require a less counter-weight than the first; the third a less one than the second; the fourth a less one than the third; the fifth a less one than the fourth; and the sixth the least of all, to make them all equally easy to be wrought up and down. By an arrangement of this kind, the greatest possible advantage will be gained by counter-weights; and the water required may be supplied in the manner alluded to in last article at page 36.

Fig. 1. Plate I., is a section of the acclivity in the line of the railway. The dotted line A B representing the supposed surface before the road-ways are cut; and C C C C the caisson-pits. Fig. 2. is a plan of one of these pits C C, with the top of one of the caissons on which railway-tracks are fixed; also an adjoining range of plunger-pits, marked 1, 2, 3, 4, 5, 6. Fig. 3. represents a section of the plunger-pits, where *a a*, is the level of the top of the pits; *b b b*, the level of the bottom; *c d e*, are three of the plungers, represented as sunk to the bottom; and *f g h*, the other three in an elevated position; *i i*, is the level of

the centre water-line; *k k k k k k k*, the upright posts that are built into the side-walls of the pits, with their rollers; *l l*, one of the strong horizontal beams that support the axles of the winches and pinions; *m m m m m m*, represent the rack-bars, with teeth, strongly fixed to the diagonal frames of the plungers. The winch-handles fitted to the axles of the pinions are marked *n n n n n n*, whose teeth work into the racks, by which the plungers are elevated and depressed as required; these winch-handles are prevented, at pleasure, from getting round, by pulling out iron-bolts inserted in the beam *e e*, either above or below the knee of the handles.

A hand-spoke wheel may be used as preferable to a winch; but should more power be required than can be overcome by either of these, a toothed spur-wheel and two pinions may be applied to the working of the racks; viz. a pinion on the axis of the winch, to turn a wheel that has a pinion on its axis, to work into the teeth of the rack: rollers are to be placed at the back of the racks, to keep their teeth a proper depth into those of the pinion. This scheme will be found equally suitable for any intermediate weight between the greatest and the least that it may be fitted up for.

While devising methods for overcoming ascents and descents on railways, a plan occurred, that appears to possess properties fully more applicable to general utility. By this plan, waggons or carriages of any kind, as also boats on carriages, having wheels to correspond with the breadth of the railways, will

continue as horizontal in passing up and down inclined planes even of 45° of elevation, as if travelling upon a level railway. The first idea of this was to construct waggons on purpose, for ascending and descending upon these steep inclined planes; but an improvement was afterwards thought of by which carriages of almost every description may pass up and down these inclined planes, provided that their wheels be fitted to the railways.

All public lines of railway will require two distinct sets of railway tracks, and, consequently, the inclined planes upon it must be fitted up with machinery that will take up carriages upon the ascending plane, either empty or loaded, at the same time that empty or loaded carriages are passing down the descending plane; and, in like manner, let down on the descending plane either empty or loaded carriages, when there are neither empty nor loaded carriages to pass up the ascending plane:—all such properties are requisite for general service on a public line of railway. Inclined planes that have upon them ascending and descending tracks, are called Double Inclined Planes; but those about to be described may be called Double-railed Inclined Planes, as both the ascending and descending planes have two sets of rails.

The first step to be taken towards the formation of these inclined planes, is to commence at the foot of the acclivities that are proposed to be ascended and descended, and to cut forward a level roadway of a necessary breadth for a double-railway, not ha-

ving less than 4 feet in breadth between the two railways, until a perpendicular height is gained of from 8 to 10 feet. This face is not to be left perpendicular, as in the last proposed method; but is to be sloped away towards the rise of the acclivity with an uniform regular shape, until it form an angle of 45° with the horizon, or an outward angle of 135° with the level line of the roadway. At the top of this inclined plane, we again commence and cut forward a similar roadway, until the face of the cut be such as will admit being formed into another inclined plane like to the first: and, in like manner, continue to cut forward roadways, and form inclined planes all the way to the top of the acclivity, or else to a height where it may be judged proper to strike off with a level railway. All these steep slopes are to be carefully flagged with well dressed durable stones, laid in lime; and the sides of the roadways are to be properly built with a face-building, until it reach near to the foot of the paved slopes. Strong walls are also to be built on each side of the slopes, with large hewn stones: the tops of these walls are to be carried up parallel with the slope of the pavement; and the height of each of these walls, measuring at right angles with the pavement, may be 3 feet; and they are to be carried up to a level with the upper roadway. A middle wall of strong mason-work, of 4 feet in thickness, is to be built exactly up the middle of the paved slopes, corresponding precisely as to height and slope with the side walls, and which are also to be carried to a level with the upper roadways.

Matters being thus far arranged, the next step is to lay all the level roadways with rails, so as to form railways of say 4 feet 3 inches between the tracks. Rails are not only to be laid along the level roadways, but they are also to be laid up along the inclined paved planes, in a secure and substantial manner. There is likewise a rail to be laid upon the top of each of the side-walls of the inclined planes, in a parallel manner to those upon the pavement, and which are to be securely fixed within 3 inches of the face of the walls. The length of a horizontal line between the rails that are upon the pavement, and those that are upon the top of the side-walls, will be found to be (at the height that these walls are proposed to be built), 4 feet 3 inches nearly.

Now, if a carriage be made with two pairs of wheels, all of the same diameter, having its fore-wheels to correspond with the railway tracks that are upon the pavement, and its hind-wheels, with a longer axis, to correspond with the distance between the rail-tracks that are fixed upon the top of the side-walls; and the axles of the two pairs of wheels placed at the calculated distance of 4 feet 3 inches from each other, then will the body of such a carriage, when passing up and down these inclined planes, remain equally level, as if travelling along level railways. A carriage, such as we have described, could not travel along a railway with single rail-tracks, owing to the axles not being both of one length; and to have a railway with two rails on each side would be attended with much additional

expence; or to have small rollers on projecting ends of the hind axes, would give the carriages an awkward appearance; therefore, the following method is proposed, which is, to sink a place at the foot of each of the inclined planes, of a length, breadth and depth, fit to receive a platform carriage with four wheels, its fore ones to fit the rail-tracks on the pavement, and its hind wheels to fit the tracks that are on the top of the side-walls. Upon this carriage two rails are to be fixed, to correspond exactly with those upon the level railways, and to butt against them. A stayed iron draught-bar is to be strongly fixed to each side of this carriage, to fix the ropes to, by which the machinery employed is to raise up or let down these carriages. The position of the draught-bars will be regulated by the centre of gravity of the weight that is to be brought up. From this arrangement, it will appear, that a waggon, such as we have placed upon it, or any cart or carriage whatever, that has wheels corresponding with the railway, will readily enter upon these platform carriages; which may easily be prevented from running off, while ascending or descending upon the platform, by means of a piece of chain, fixed near its fore end.

As these platform carriages are only intended to pass alternately up and down the inclined planes, for carrying the railway carriages, it is requisite, that, on reaching the top or bottom, the rails shall also correspond, that the waggons may leave the platform on the chain being unhooked that is to prevent them from running prematurely off.

An experiment was lately made upon a railway having a declivity of $12\frac{1}{2}$ inches in 100 feet of length, with a loaded coal-waggon, whose weight, including the carriage, was 2 tons. A middle-sized old man pushed this waggon down the declivity, and gave it a considerable motion; the waggon was stopt, when the same old man set his back against it, and brought it up the above mentioned acclivity without much apparent difficulty. This is stated to shew, that where the distance between the inclined planes is short, the carriages may be pushed along with ease by one man upon a level railway; or he might be put in possession of a kind of accelerator, to be wrought by treadles, by which he could employ both his weight and his strength, by laying hold of two handles to give greater power to his feet. Or, in place of cutting forward a level roadway to the ascending plane, it may be cut with an easy declivity, and the railway to the descending plane with a gentle acclivity, by which the carriages, on being put in motion by hand, would run of themselves to the inclined planes. By forming the roadways in this manner the ascending plane would become somewhat more, and the descending plane somewhat less in height, than they would have been, had the roadways been level; but as it may be best to have both inclined planes of the same length, it will only be necessary to make the descending plane with a longer slope; for, although 45° is here mentioned, there is no necessity of adhering to that angle.

Where the distance between them is great, the level railway, and a horse to be employed to pull the carriages between them, is to be preferred. Although it is practicable to make inclined planes on the same principles as those described, to take up more than one waggon at a time; yet the power that would be required, and the several disadvantages that would attend it, are such as will much more than counterbalance any advantage or gain to be made; for which reason there need be no hesitation in recommending the taking up or letting down only single waggons at a time; and possibly it may be found that the most beneficial and eligible weight to be carried will not exceed 2 tons, including the weight of the carriage. The mechanical power of an inclined plane, having 45° of elevation, reduces the weight of 2 tons to that of 28.284 cwt.; to which is to be added for friction, the power required to move it along a horizontal plane.

Fig. 4. Plate I. shews an acclivity cut into four inclined planes, B C D and E, in the manner proposed; the dotted line A E represents the original of the surface, and the line E F the perpendicular height gained by the four inclined planes. In Fig. 5. A B C D is a section of one of these inclined planes, showing one of the side-walls built with hewn stones; the dotted figure *a b c*, one of the platform-carriages at the top of the inclined plane; F G where the waggon *d e*, in dotted lines, has entered upon it; *f g* is another platform-carriage at the bottom of the

plane, with a waggon *h*, *i*, upon it, the fore wheels of which are fixed with a piece of chain, to prevent its running off the platform-carriage when in the act of ascending or descending. The wheels of this waggon are upon a level with the lower line of railway H I. The wheels of the platform-carriage are represented as travelling upon the pavement K L, and upon the top of the side-walls M N; while *k l*, represent a side view of part of the frame-work of the coiling cylinders, and *m*, an end view of one of the cylinders; *n n*, represent one of the ropes, and the dotted figure at *o*, one of the stayed iron-draught-bars, for fastening the ropes by which the carriages are drawn up or let down. Fig. 6. is partly a cross-section, but chiefly an elevation, of one of these inclined planes; *p p p p*, the rails in the bottom of the plane; *q q q q*, the rails that are upon the top of the side-walls, and *r r*, the waggon upon it. Fig. 7. is an elevation of the frame-work and machinery to be placed at the top; of which M N, Fig. 5. forms a part. The coiling cylinder A A, is to be placed to suit the ascending plane, and the cylinder B B, to suit the descending plane. At M a coupling-box is introduced, by which the axis of the coiling-cylinder A A, can be disengaged from that of B B, at pleasure. Upon the axis of the cylinders CD, a screw-wheel E is to be fixed, and wrought by a double-threaded endless screw S, that is upon the axis F F. On the lower end of this axis, another screw-wheel G is fixed, to be wrought by another two-threaded endless screw H, on whose axis are two

winch-handles, as represented in Fig. 8. The one end of the ropes that are upon the coiling cylinders AA, and BB, is to be fastened to the stayed iron draught-bars already described. Upon the same axis CD, the cylinder I is to be fixed. One end of its rope is to pass over a pulley-wheel K, placed over a deep pit *t t*, suitable to the length of the inclined planes, and to have a heavy counterbalancing weight L fixed to it, as represented in dotted lines Fig. 9. At M the same may be effected by means of wheel and pinion apparatus.

A third method by which waggons or carriages may be drawn up or let down these steep inclined planes, is fully represented by the model accompanying this paper, which is made to a scale of 1 inch to the foot, and is delineated in Fig. 10.; the other parts of the frame-work and machinery being in all respects similar to Fig. 7. But instead of the double-threaded endless screws G H, let two bevelled wheels *a b* and *c d*, of 32 teeth each, be placed as in Fig. 10., so as to turn freely round upon the axis without giving it motion; into both of these wheels the pinion *a c*, of 15 leaves, takes equally deep, so as to turn them both; between the wheel *a b* and *c d*, a stub-box *s*, with a square socket, is to be fitted upon a square part of the axis, so as it can be easily moved up or down: by putting the pinion *ac* in motion, it will cause the two wheels *a b* and *c d* to revolve, but in contrary directions, and without moving the axis *m n*; but if the stub-box be pushed up until it encounters the stubs on the wheel *a b*,

then will that wheel move the axis *m n* in one direction; and if the box be brought down, until its stubs shall act against those of the wheel *c d*, then will that wheel carry round the axis *m n*, in a contrary direction to that of *a b*. Upon the outer end of the axis of the pinion *a c*, is to be fixed a weighty fly-wheel W W W, of 12 feet diameter, and not less than a ton in weight; upon the axis of this fly-wheel and pinion *a c*, are to be formed two cranks *v*, *v*; these cranks are proposed to be wrought by the two treadles *t t*, connected with the cranks by straps.

Although a fly-wheel, when acting constantly in a machine, constitutes no part of its power, yet, in many machines, it is a valuable regulator of their motion; but the manner proposed of making use of a fly in the present case, is with a view to make it act as a *reservoir of power*, the motion required being of a short continuance; for it is well known that one man may give such a fly as the one proposed a velocity, that the strength of 100 men could not put an immediate stop to its motion. A small lever is to be attached to the stub-box *s*, made to act upon either the stubs of the wheel *a b* or *c d*, or upon neither of them. (This lever is not introduced into the sketch, but it is shewn in the model lodged with the Society.) There are to be three notches so placed to receive the end of this lever, that if its end is put into the first notch, the wheel *a b* will move along with the axis *m n*; if put into the third notch, the wheel *c d* will move along with the axis,

but in a contrary direction to that of $a\,b$; and if the end of this lever be put into the second or middle notch, the wheels will then both revolve independent of the axis $m\,n$. The handles $h\,h$, are to be placed at a convenient height, for the man to lay hold of, who is to work the treadles with his feet, which will add considerably to his power; the cranks being also kneed in opposite directions, gives an advantage to his feet that is not to be gained by a single winch-machine wrought by hand. Now, suppose a waggon upon a platform-carriage such as we have described, ready to ascend the inclined plane, and the end of the stub-box lever in the middle notch, let the man give the fly an accumulated velocity, by working the treadles with his feet, increasing his power by the strength of his arms. When an active boy, properly trained, shifts the end of the stub-lever from the middle notch to the first, then the platform-carriage with its waggon will gradually ascend, the man all the while continuing his exertions on the treadles; the boy watching when the carriage is at its proper height, throws the end of the stub-lever again into the middle notch, and the fly being still kept in motion, will soon regain an accumulated velocity to draw up the next waggon; the carriage of the descending plane all the while moving up and down its plane, acting in part as a counter-weight to the carriage of the ascending plane; but, if descending with a loaded waggon, it may then be brought to act as a counter-weight. The ropes of the descending waggons are

coiled round their barrel, contrary to those of the ascending ones. When letting platform-carriages down the plane, the man at the treadles will only have to keep the fly in motion without much exertion; and the boy will have to shift the end of the stub-box lever into the third notch, taking care instantly, on observing the proper mark or index, to shift his lever back into the middle notch.

One end of the rope of the cylinder I is to be made to pass over a pulley-wheel K, Fig. 9., supported by two horizontal beams *p* and *q*, over the pit *t t*, and tied to the counter-weight L. When the platform-carriage is at the bottom of the inclined plane, its outer-end rests upon benches of stone, that prevent the rails from sinking past those of the lower railway. And, for the like purpose, there is to be fixed below the middle of the fore end of the platform-carriage a strong piece of iron, projecting downwards about 2 inches, and to be 4 inches in breadth; and there is also to be a strong iron-axis placed across, near the top of each inclined plane, that has a piece in its middle that projects 4 inches, and is 4 inches in breadth. These axles are to be so placed, that if they be turned one-third round, by means of a lever, when the platform-carriage is at the top of the inclined plane, the projecting pieces will lay hold of the 2-inch pieces that are fixed below the fore end of the carriages, in such a manner as to keep the rails upon the platform-carriage exactly upon a level with those upon the upperrailway.

AB Fig. 11. represents the axis, *x* the 4-inch pro-

jecting piece, and L the lever, the end of which is to be held in the required position by an iron-bolt, that draws out or is pushed in at pleasure. CD Fig. 12. shews a section of part of the platform-carriage, &c. where *r* is the 2-inch piece that projects from the fore-end of the carriage, *a* the axis, *b* the 4-inch projecting part of the axis, in a position that keeps the end of the carriage at its proper height; and the dotted part *z*, shews the position of the 4-inch piece, when the carriage is left at liberty to descend the plane. This axis is not introduced into the model. For steadying the frame-work, iron-stays may be carried outwards, and hooked into rings fixed into large stones sunk into the ground.

Another method may be simply mentioned, by which waggons may be drawn up or let down steep inclined planes, by the aid of counter weights only. This may be done, by placing a coiling cylinder, of a particular construction, over an oblong pit of a necessary depth, the cylinder to be connected with machinery similar to that already described. At the bottom of this pit, a row of weights are to be placed in a line with the length of the pit, at a small distance from each other. The cylinder is to be so constructed that a man, with a winch-handle, wheel and pinion, can with ease coil upon this cylinder each of these weights, one by one, until he shall have a sufficient counterbalance for the weight of the carriage to be drawn up; when all the weights that are drawn up, shall act upon the pit-cylinder as one weight, and draw up the carriage

that is upon the platform. In like manner, on knowing the weight of a descending waggon, the person that has the charge of the cylinder can attach to it the necessary quantity of weights, to admit a descending waggon to pass down the plane. To the end of this cylinder a brake-wheel is to be fixed on the same axis, for regulating its motion.

In situations where a stream of water can be brought forward to the top of a single inclined plane, an oblong pit may be sunk of a depth answerable to the length of the inclined plane, and a level mine cut to its bottom to free it of water. Over this pit is to be placed a long coiling cylinder, having a range of buckets suspended from it by ropes; the buckets are to have valves to open upwards when necessary, by means of small cords. The ropes that are to pull up the waggons are to pass over pulley-wheels placed in a proper position, and at a proper height, the one end of the ropes being fixed to the waggon, and their other end to the pit-cylinder. The weight of water that each bucket holds being known, will enable the engine-man to know what number to fill for the weight of the waggon to be drawn up: on the necessary number being filled, they will then descend and pull up the waggon,—a brake-wheel is to be fixed on the axis of the pit-cylinder to regulate its motion. When the buckets are at the bottom of the pit, should it be required to let down a loaded waggon, the counter-weight is to be adjusted to the weight to be let down, by pulling a necessary number of the valve-

cords, to permit the water to escape from the requisite number of buckets,—the ascent of the buckets, and descent of the waggon, to be regulated as before by the brake-wheel. Should all the buckets be at the bottom of the pit, at a time when they are wanted to pull another waggon up, the ropes of all the valves are to be pulled, that the buckets may be all emptied; and for this purpose there is to be, besides the range of buckets already mentioned, a large bucket, with a valve in its bottom, that opens on reaching the bottom of the pit, having its rope coiled the contrary way round the pit-cylinder to that of the range of buckets: this large bucket is to be so suspended from the pit-cylinder, that when all the other buckets are at the bottom of the pit, it shall be at the top of it. By filling this large bucket with water when at the top of the pit, it will descend, and occasion all the empty ones to ascend to the top of the pit; and when refilled, they will again be in readiness to pull up another waggon. By thus having a range of buckets, the counterweight can be so regulated as to answer the weight of different carriages, whether loaded or unloaded. It is unnecessary to point out the simple manner in which the water can be directed into the different buckets, and stopt when not wanted.

The perpendicular height of canal-locks is very generally about 8 feet. This appears also to be a suitable height for steep inclined planes, for the greater that the height is, the greater will be the disproportion of cutting and mason work between a

high and low inclined plane; for by calculation it will be found, that in the formation, one of 16 feet high will contain four times the number of cubic yards of solid cutting, compared with one of 8 feet, and require four times more face buildings, and these of much greater strength.

At these short inclined planes, the whole ropes and machinery may be roofed in, and kept dry in all kinds of weather; and under the same roof the engine-man and his boy may have a cabin. It is with a view to reduce the number of horses kept, that these short inclined planes are so much recommended, as also to find employment for industrious labourers. Machinery for these inclined planes may be easily contrived to be wrought by horses, but this would require much more space than the machinery proposed. To employ the carriage or waggon horses, would only tend to retard a regular conveyance, for many of the horses that will pass along a public railway, would in all probability be found awkward and untractable in the working of machinery.

A level line of railway will unquestionably be the most suitable for general use, yet it may be said that a fixed line of draught is against the horses. This objection may be removed by having draught rings at different heights, that the drivers may shift the height of the traces occasionally; and if springs (similar to those proposed by Sir Alexander Gordon,) or the grasshopper-springs of gigs, were fixed to the front of railway-carriages to yoke the horse

wheels of 3 inches in breadth, each inch and half of the flat rail will, in this case, only support 1 ton; and as friction increases in proportion to the weight that is to be moved, therefore the friction in both railways will be similar, provided that all the acting parts are equally smooth. (This is applicable to rolling, not to rubbing bodies. See Vince on wheel-carriages, and Cummins on broad and narrow rimmed wheels.) But a source of friction arises from edge-rails, that flat-rails are not liable to, which is, when the wheels are deeply grooved by the edge-rails, the bottom part of these grooves forms that part of the wheels of a less diameter than that of any part of their sides; and being formed by the rails, both the bottoms and the sides of the grooves will act against the rails, the bottom parts having a tendency to go swifter than the sides. It is therefore evident, that, at every different depth of the grooves, an inclination to a different velocity in the wheels will take place, the slower parts retarding the swifter, and the swifter parts dragging the slower, and producing an effect somewhat similar to what would be produced, by drawing straight forward two wheels of different diameters, fixed upon the same axis.

The flat or plate-rails are made of various dimensions, of from 3 to 4 feet in length, 3 to 5 inches in breadth, and 1 inch in thickness, with projecting ledges to keep the wheels within the tracks, of from $1\frac{1}{2}$ inch to 3 inches in height, and a flange below, of about 2 inches in depth at the ends, and $3\frac{1}{2}$ in the middle, shaped in the best manner to give strength.

The rails forming the inner part of a curve, should be fixed a little lower than the other, and the rails set a little under the gage, so as to bring the sides nearer together than in the straight parts. It is certainly a great inducement to give the flat rails a preference to the edge ones, that their wheels are suitable for travelling, either on the railways, or upon common well kept hard roads. In the account given of the Surrey railway, which is 26 miles in length, it is said, " The rail-wheels are 2 feet 5 inches high, the felloes or rims of the wheels are 2 inches broad, and nearly as thick, with 12 spokes; the sharp angles are rounded off, so that these wheels are capable of being used without damage on any hard common road, a very principal advantage attending the modern use of railways. The axles of the wheels are fixed at 2 feet 7 inches distance, the waggons are 7 feet 9 inches long, 4 feet 5 inches wide, and 2 feet 4 inches high; the weight of the above waggon is $3\frac{1}{4}$ tons."

To meet the opinion of those who are partial to the action of narrow surfaces, the flat rail-wheel may be made 3 inches broad in the felloes, and $\frac{3}{4}$ths of an inch, bevelled away to each side, leaving a space of only $1\frac{1}{2}$ inch in the middle, to roll upon the flat rail, being equal to the common breadth of edge-rails, and which would not prevent them from travelling on common roads, as the rings of all wheels soon wear circular across. Diagonal brushes may be so suspended to a gang of waggons, as will, without the aid of the waggon-driver, clear the flat rails of small

stones and gravel, and diagonal scrapers may be used in place of brushes, in wet weather. To deepen the horse-track of flat rails, whose ledges are on the inside, and to make the ledges somewhat higher, would tend much to prevent gravel and small stones from lodging upon the rails; and would not occasion a horse, of the height generally used for waggons, to travel below the best line of draught, which is, when the traces form an angle of about $18\frac{1}{2}$ degrees with the line of the road. When the horse-track is made deep, gutters ought to be cut along-side of the railway, somewhat deeper than the horse-track, and covered at the passing places; outlets should also be made under the rails on each side to let off the water from the horse course in wet weather.

Experiments were made on Mr Wilkes of Measham's railway, near Loughborough, when a moderate sized horse, in the presence of a Committee from the Society of Arts, did draw upon it with ease, down hill, (the descent being one foot in a hundred) 30 tons, and 7 tons up hill, independent of the carriages. In the Philosophical Magazine for July 1811, are the following remarks on waggons and rail-roads: "The waggons on our cast-iron rail-roads have not received the improvements of which they are capable; but with their present disadvantages, the following facts will evince the great saving of animal force to which railways have given rise; first, with a declivity of $1\frac{1}{4}$ inch per yard, one horse takes downwards three waggons, each containing 2 tons; second, in another place, with a rise of $1\frac{6}{10}$ths of an

inch per yard, one horse takes 2 tons upwards; third, with 8 feet rise in 66 yards, which is $1\frac{5}{11}$ths of an inch per yard, one horse takes 2 tons upwards; fourth, on the Penrhyn railway (same slope as above), two horses draw downwards four waggons, containing 1 ton of slate each*; fifth, with a slope of 55 feet per mile, one horse takes from 12 to 15 tons downwards, and 4 tons upwards, and all the empty waggons; sixth, at Ayr, one horse draws, on a level, 5 waggons, each containing 1 ton of coal; seventh, on the Surry railway, one horse, on a declivity of 1 inch in 10 feet, is said to draw 30 quarters of wheat."

The formation of roads, and the preparation of road-materials not being altogether foreign to that of rail-roads, it was intended to give some account of the principles of machines for breaking new quarried stones (not boulders) of all sizes, from that of 2 stone weight down to any required size for the formation of roads, the machines to be wrought by water, steam, wind, or animal power. Sketches of these machines were shewn to a scientific friend, so long ago as 1806; but having lately seen it mentioned in the newspapers, that Messrs Kay and Routledge have mounted a machine for breaking stones for roads

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* At Penrhyn railway, the horses are usually worked three in a team, and generally take down about 20 waggons, containing each one ton of slates, exclusive of their corn-chest and a barrel of water for wetting the rails, to render the draught more easy. (*Editor of this article.*)

between Bury and Bolton, wrought by a rotatory steam-engine, it is thought unnecessary to enter, at present, upon the subject of roads, or that of the preparation of road materials.

Some of the most celebrated Engineers have given it as their decided opinion that railways are preferable to small canals. Railways may be constructed in a much more expeditious manner than navigable canals; they may be introduced into many districts, where canals are wholly inapplicable; and in case of any change in the working of mines, pits or manufactories, the rails may be taken up, and laid down again, in new situations, at no very great expence.

The subject of rail-roads is far from being yet exhausted; and it certainly deserves every possible consideration. There is no plan, scheme or undertaking, that would lead to more extensive and permanent improvements, than that of extending branches of railways, from public lines, to all the improveable uncultivated districts in the kingdom; which, in time, would become a source of national wealth, and afford permanent and profitable labour for all out of employment.

For the historical part of this Essay, see Rees's Cyclopædia; Brewster's Encyclopædia; English Encyclopædia; Curr's Coal Viewer; Holmes on Coal Mines; Aiton's Agricultural Report of Ayrshire; Observations on a General Railway, published by Baldwin, Cradock and Joy, London, 1821; Adam's Lectures by Jones; Aitken's Picture of Newcastle-upon-Tyne, 1812; Smith's Mechanic.

Remark.—Mr Scott, the author of the foregoing essay, has been at much pains in visiting the principal railways in Scotland, in consulting works which treat upon the subject, and in preparing drawings and models for illustration. It may, however, be proper to mention, that although the suggestions contained in his essay are ingenious, and may turn to useful account, yet the Editor of this article would not be understood as giving any opinion as to their application in practice.

ESSAY by MR GEORGE ROBERTSON, Bower-Lodge, Ayrshire.

The first mode of conveying goods, by the aid of machinery, would, in all probability, be by *dragging them on sledges.* This manner of conveyance is generally conceived to *double* the power of carriage,—requiring only one pound weight to drag two along a level surface *, and hence there is evidently a saving equal to one-half, when compared with carrying the burden on the shoulders or in the hand.

* This, although a general notion, does not hold uniformly true. It depends, in a great measure, on the state of the roughness or of the smoothness of the materials to be dragged along. Thus I have found, that, whilst a piece of unpolished cast-iron required one-half of its own weight to pull it along a smooth deal; yet a piece of the same metal polished, and a piece of polished marble, were each dragged along by a weight not exceeding one-third of their own.

At what time the sledge came to be mounted on *wheels* in this country I have no information; but, though doubtless a very ancient invention, it was probably long before wheel-carriages came into general use in Scotland. Even in my own day, the sledge, for several purposes in husbandry, was not laid aside; for after carts mounted on wheels were getting more and more into use, still every farmer had his sledge. These were employed in all works, but more especially for bringing crop of every description from steep banks or hill sides; and, to this day, under the name of a *Slype*, a sledge is frequently used in dragging heavy stones from off land (to which service it is peculiarly applicable from its lowness); and the sledge is still used in fetching home the peats from the hill-tops, where, from the steepness of the tracks, a cart is not so well adapted to the purpose. The sledge is indeed still recognized in several turnpike tables of rates. In the cases above exemplified, it is a very useful implement of husbandry, and it is also obtained at little expence. The price of a single pair of cart-wheels would purchase half a score of sledges.

What precise power is gained by the application of wheels to carriages, seems to have been hitherto ascertained more from experience than previous deduction. On a plain surface, although it may not be quite smooth, it should, from the experience derived from the carts a long time used in this country, appear to have been perhaps about six times more power gained, in rolling forward goods

upon a wheeled vehicle, than by dragging them on by means of a sledge. Thus when a horse was able to drag 2 or 3 cwt. (including the sledge itself) he was found able to drag 15 or 18 cwt. as easily on a cart mounted on wheels, originally abundantly clumsy, and weighing perhaps a third part of the whole lading drawn. This quantum of power seems, in fact, to have remained long as the ultimatum of the power of a single horse, in the ordinary practice of the country. It has been considerably augmented of late, from the better state in which the roads are now kept, and the better lines of direction adopted, and not a little from the greater correctness of the machinery in all its parts. A horse, in many parts of the country, more especially in the vicinity of Glasgow, now draws 24 cwt. besides the cart itself, which may be 6 or 8 cwt. more. In many other districts, however, 12 cwt. (on a single horse-cart) is the more general lading, which, after all, is more than falls to the share of each of the large horses in the heavy 6 or 8 horse-waggons of England, where the owners are still willing to let them creep sluggishly along with frequently less than 8 cwt. each, exclusive of the cumbrous waggon itself.

The expence of carriage in all cases adding considerably to the price of the goods conveyed, has led always to a desire to reduce it; and which, in the course of the last forty or fifty years, has been accomplished to a considerable extent, from the various devices fallen upon. These, like to all other

improvements, have not been brought to perfection all at once, but have been advanced more and more, by succeeding inventions, from time to time, adding something new to what was formerly known.

The first attempts at Railway making in Scotland, seem to have been accomplished by making the wheels roll along narrow beams of wood laid in parallel lines, at such a distance as corresponded to the width betwixt the wheels on which the waggon was laid. The advantage derived from this device was little less than what was obtained from the wheeled cart itself compared with a sledge; for, while 12 cwt. was the ordinary load, on the ordinary roads, put on a single horse cart, 48. cwt. was moved with equal ease on the *railway*, the appellation given to this new construction of a road. It is to be observed, that to make the wheels connect more accurately with the narrow beams, which were raised *convexly* above the surface of the ground, these were made *concave* in the rim, so as to fit them correctly.

This wooden rail-track was soon found to be very perishable, getting unequal on the surface, wearing by the friction of the wheels, or wasting from the influence of the weather. This led to an improvement in the *form*, and an alteration of the *material*. The rail-track was now made of *cast-iron*, and concave; whilst the wheels were made convex in the rim, the more readily to suit the track they were to travel in. This device was found to have more advantages than were at first in contemplation; for, besides being *more durable*, which was all that

was intended, the wheels were found to glide *more easily* along; so that a horse could now draw 60 cwt. as easily as 48 cwt. before.

But the invention was destined to undergo a greater improvement still. The convex form of the rail-track was recalled, and the wheels were again made concave. The rail, too, was reduced in thickness to 1 inch instead of 6, as iron is known to be stronger at 1, than wood at 6 inches thick. The difference which this makes in the draught was hardly to be preconceived. For this new mode of application, in which a concave rimmed wheel rolls along the upper edge of a convex iron-rail, is so advantageous, that instead of 48 cwt. as at first, on the wooden-rail, and 60 cwt. as on the concave iron-rail, a horse can now draw with equal ease 6 tons, or more.

The concave track, although made of iron, laboured under a great disadvantage, in being liable to accumulate sand, mud or gravel, which occasioned much interruption to the wheels. The *edge*-rail (as the other is now called), is altogether free of such occurrences; for it is elevated 2 or 3 inches above the level of the path-way, and presents at same time so acute a surface, that hardly a single grain of sand can find shelter upon it. In the course of this Essay, I trust I shall be able to shew, from improvements that may still be made, that much more than the last mentioned weight (6 tons), may, with equal ease, be drawn by a single horse. Even in one case that I know, (Mr Laing's railway near Edinburgh), 11 tons, including the weight of the waggons, is

sometimes drawn by one horse. I mean to say, that even this great draught may be greatly exceeded*.

At what particular period tram-roads or railways were invented, I have not been able to ascertain. The farthest back known to me in Scotland, is that of Alloa, mentioned in the Statistical Account of Scotland, vol. viii. p. 617, which is stated to have been made in 1768, being fifty years ago. It is to be remarked, that originally, or with few exceptions, railways were constructed only in the cases where coal-works were situated near the coast, which afforded an opportunity of giving them an inclination downwards, that greatly facilitated the conveyance. It was only to be guarded against, that the descent to the shipping-port should not be greater than would admit of the empty waggons being drawn up again, with the same power that carried the full ones down. In the Alloa case, the lading, instead of being all laid as before on one waggon, was divided among three, each $1\frac{1}{2}$ ton or $4\frac{1}{2}$ tons in all, besides the waggons, pro-

* The following are the usual ladings on the following railways known to me. The Earl of Eglinton's at Ardrossan, a concave iron-track, from 3 to 6 tons, the distance about one-half mile. The Duke of Portland's at the Troon, 8 miles, a flat iron-track or plate-rail, generally 4 tons 13 cwt. Messrs Taylors' at Ayr, an *edge* rail-track, commonly 8 tons, sometimes 10, about a mile. Mr Laing's as above, an edge rail-track, 3 miles 3 quarters, generally 8 tons 16 cwt., sometimes 11 tons as above, including in all these cases the weight of the waggons. The Earl of Eglinton's and Messrs Taylors' railways, are on a dead level. The Duke of Portland's on a descent of 8 feet in the mile; Mr Laing's is on various lines of draught.

bably not less than 2 tons more, a lading not generally surpassed, with all the improvements on the subject since made. But the track in this case was not level; it inclined considerably downwards to the harbour. The rate of descent is not mentioned, but may be conceived to have been 1 foot in 90 or 100, as either of these would be sufficient. Where an equal lading is to be carried, both in going and returning, it has hitherto been believed that the railway must of necessity be altogether level. In the course of this Essay, I mean to shew, that a railway altogether level is not necessary either way.

The application of a railway through a country of unequal surface, has been all along very much desired. In a case of this kind, the carriage of goods by a *canal* is accomplished by means of *locks*, which, at the required distances, either raise or lower the vessels as may be wanted, 6, 8, or 10 feet at once. To give the *railway* the same advantage, *the inclined plane* has been thought of. This was in the days of the *single* waggon, in which the whole lading was to pass at one time. As this could not be accomplished *upwards*, with the same power that was required to draw the waggon on a level, some devices were fallen on to assist. The most obvious, was to make the waggon that travelled downwards, draw up, in its descent, on the inclined plane, a corresponding waggon, travelling the opposite way. This, it must be evident, could not be accomplished at every ascent or descent that might occur;

for these, in a country of uneven surface, might take place in every hundred yards, or oftener; therefore, the construction of a railway track in such circumstances, became similar to that of constructing a canal. A process of levelling became indispensable. Moderate *risings* in the surface were cut through, and moderate fallings or hollows were filled up, so as to have a considerable length of level track, perhaps for several miles together, till, from stage to stage, and by various windings, the whole declivity collected into one point might amount to 8 or 10 feet at once, and thus might make it worth while to erect the necessary apparatus for conducting the ascending and descending waggons in their respective courses along the inclined plane, to a level track in both directions.

Now that the practice of dividing the lading among several waggons is getting more into use, the operation of the inclined plane may be simplified, by being itself divided into smaller portions, even to a *single foot* or less, as it occurs. Hence, without any machinery at all to aid the ascent or descent of these lesser inclined planes, (say of *one in four* on every 6 inches perpendicular), as they take place, they may be passed upwards by a *string* of waggons, one by one at a time; for the first will be over before the second begins to ascend, and so all the rest in train; and where there are but six waggons in the draught, the horse will never have more than the sixth-part of the lading to hawl up the inclined plane at a time; the other five parts being always

on a level plane. Should the lading be divided among ten waggons (as I shall be able to shew is more eligible than a lesser number), the operation of going over these acclivities will be still more easy.

The expence of forming a track-way thus constituted must be vastly reduced, if compared to the expence of cutting through heights in one place, and filling up hollows in another, in order to make a dead level throughout. For, in this case, little or no levelling will be required, whilst the track itself, unimpaired with *forced earth*, will always remain firm at the bottom. But, in an after-part of this Essay, I shall humbly submit to the consideration of the Honourable Society, a scheme, in which, through a country of moderate heights and hollows, a railway may be conducted, without having recourse even to the expedient of these lesser inclined planes at all. In the mean time, I shall proceed to investigate some of the leading circumstances connected with railways, in order to ascertain the grounds on which improvements may still further be obtained.

I. *Of a Horse's Power in Drawing.*

In all the Essays that I have read on this point, the power of an ordinary horse in drawing is said to be equal to counter-balance 80lb. Avoirdupois, suspended over a pulley; and it is said that, with a lading that requires him to exert such a force, he is able to work two yokings a-day, of four or five hours each. My

opinion is, that he can do much more, even to the double of that, as happens very frequently in the common operation of ploughing, where it requires a power of exertion in a pair of horses, equal to from 224 lb. to 336 lb., or from 2 cwt. to 3 cwt. to accomplish the work, according to the nature of the soil and size of the furrow. I state this, however, more from report than from precise investigation.

Be this as it may, it is ascertained from experiment, that, on a level and smooth surface, 1 lb. weight suspended over a pulley, will draw 80 lb; so that if the ordinary power of a horse be estimated at only 80 lb., he will be able still to draw 6400 lb., or nearly 3 tons. This we know on a railway, is greatly less than a horse can continue to draw for hours together. In Glasgow, and in the vicinity of that city, where the roads or streets are neither all level, nor at all smooth, horses very frequently draw 2 tons; which, although this does not much exceed $\frac{2}{3}$ds of 6400 lb., requires much more exertion than a horse is put to on a railway, even where he draws 20,000 lb. (about 9 tons) and more. This will appear in the sequel.

That a horse is capable of an *occasional* exertion many times greater than the supposed ordinary rate of 80 lb., must be admitted even to *ten times* and upwards of that rate. This happens from time to time, on, I may say, every road whatever,—more especially on all the roads in Scotland, among which there is hardly an instance of a single mile continuing level throughout. And, what is confirmed by experi-

ence, when the rise and fall is moderate, as in the proportion of onefoot, in 30 or 40 on a short extent, to one foot in 60 or 80 on a longer, the horse is found *to stand the work better*, than if he were drawing *continually* on a flat plane. This fact, confirmed by experience, is also consistent with reason. In the case of a horse drawing continually on a level, one set only of muscles are brought into play, or, in other words, his exertion is directed for ever to *one point*, without power of relief from *change of position*. But in the more usual case, of the road being sometimes uphill, sometimes downhill, and sometimes on a level, there is an alternation of three different modes of exertion, each adapted to the change of position, as the road changes from a level to an acclivity,—then to a level,—next to a declivity, and so alternatively to a level again. Every person accustomed to manual labour, is sensible of the benefit derived from a change of position. Even those accustomed to travel in the easiest of all modes,—in a carriage mounted on springs, get tired from long rest, and are, from time to time, fain to get out and walk, even were it uphill, as a relief from the uneasiness of unvaried ease.

To shew the circumstance attending the various degrees of ascent, Fig. 1. Plate II. is constructed; in which the horizontal line AB, (suppose 100 feet long), represents the level plane, along which, on a smooth surface, 1.25 lb., hung over a pulley at B, was found sufficient to draw 100 lb. laid upon wheels. The diagonal lines A 5° 10° 15°,

&c., shew the degrees of elevation in a quadrant of 90°, the elevation *above the horizon* being represented in feet, by the respective figures on the horizontal line below corresponding to the perpendicular lines, dropt from the different degrees 5° 10° 15°, &c. In the two columns on the right, the *1st* specifies the proportion of ascent; the *2d* the power required to draw 100 up, when 1.25 draws 100 on a level. Thus, for example take an elevation of 5°, on the horizontal line of figures: when AB is 100 feet, an elevation of 5° will amount to 8.7 feet, equal to 1. in 11.494, and which will require 9.95 to draw a weight of 100 lb. up. In the elevation of 30°, the ascent is equal to one half of the whole, in this instance 50 feet, and it is equal to an acclivity of one foot in two, and will require 51.25 lb. to draw up 100; and so of the rest from 30° downwards. From 30° upwards to 90°, or the perpendicular AC, the weight required to draw up 100 is represented in a column on the left. In all these cases, the correspondent numbers on the base line AB, in this case representing pounds weight, are each sufficient to *sustain* 100 lb. on the line of ascent, but all require an addition equal to what is required to draw on a level, in order to overcome the friction in the progress of *drawing* the 100 lb. upwards. This addition, in the present case, is taken at 1.25 lb., but may be more or less, according as the track of draught may be more or less smooth, or the wheels on which the draught is laid may have a greater or less proportion to the axles on which they may be placed.

To shew the power required to draw upwards on acclivities of 1 foot in 2 or 3, 4, 6, 10, 20, 50, &c. the following Table is constructed.

TABLE.

1.	2.	3.	4.	5.
1 foot in 2	51.25	156	3282	41
do. in 3	34.583	231	2222	about 28
4	26.25	305	1680	21
5	21.25	376	1360	17
6	17.916	446	1146	about 14
7	15.535	515	983	$12\frac{1}{4}$
8	13.75	582	880	11
9	12.361	647	791	nearly 10
10	11.25	711	720	9
12	9.583	835	613	$7\frac{1}{2}$
14	8.392	953	537	$6\frac{3}{4}$
16	7.5	1066	480	6
18	6.805	1176	435	nearly $5\frac{1}{2}$
20	6.25	1280	400	5
25	5.25	1524	336	$4\frac{1}{5}$
30	4.583	1745	292	$3\frac{3}{5}$
35	4.107	1948	263	about $3\frac{1}{4}$
40	3.75	2133	240	3
45	3.472	2301	222	$2\frac{3}{4}$
50	3.25	2461	208	$2\frac{1}{2}$
55	3.068	2597	197	nearly $2\frac{1}{2}$
60	2.916	2742	186	$2\frac{1}{3}$
65	2.788	2873	178	nearly $2\frac{1}{4}$
70	2.678	2987	171	$2\frac{1}{8}$
75	2.583	3097	165	$2\frac{1}{16}$
80	2.5	3200	160	2
85	2.426	3297	155	$1\frac{15}{16}$
90	2.361	3388	152	$1\frac{7}{8}$
95	2.302	3475	147	$1\frac{13}{16}$
100	2.25	3555	144	$1\frac{4}{5}$
on a level	1.25	6400	80	1

Col. 1. in this Table shews the rate of acclivity; which explains itself.

2. The weight required to draw 100 lb., when 1.25 lb. draws it on a level, is found by dividing 100 by the corresponding figures in Col. 1., and adding 1.25 to the quotient.

3. The weight a horse would be able to draw, were his powers limited to 80 lb., and the draught 6400 lb. on a level, is found from calculating by the rule of three *inverse*, as 1.25 to 6400, what the corresponding number in Col. 2. (Take the example of 1 foot in 10. If 1.25 : 6400 : : 11.25 : 711).

4. The force he actually has to exert in each case, supposing that, from his ordinary power of 80 lb., he can draw 6400 lb. on a level, is found, from calculating by the rule of three direct, as the respective numbers in Col. 3. is to 80, so is 6400 to the corresponding numbers in Col. 4. (Take again for example 1 foot in 10. If 711 : 80 : : 6400 : 720).

5. The number of times more than his ordinary draught, is found from dividing Col. 4. by 80. The result is stated at the nearest whole numbers.

That a horse frequently draws, without any apparent difficulty, on an acclivity of 1 foot in 40, is to be seen every day, and on every road, and this for a considerable stretch at a time. This is nevertheless an exertion *three times more* than is required on a level. One foot in 20 is often met

with, which requires *five* times more exertion; and even 1 foot in 10, where the pull is not very long, is surmounted in a direct ascent, although it is *nine* times more difficult than the draught on a level. But when the ascent becomes considerably more, as in the case of 1 foot in 6, of which there are still some examples, the horse seems for a moment to make a pause; but, as if endowed with the sagacity of a mathematician, he soon takes the road in *angles*, and by alternating in a zig-zag track gets over the difficulty; although it would be about 14 times more work than on a level, were he to attempt it, on a direct pull uphill. One foot in ten is, as stated above, nine times more difficult than the draught on a level, and as there is seldom less than a ton weight on an ordinary loaded cart (including the cart itself), it shews what a vast exertion a horse can occasionally make, being in this case a draught equal to 9 tons on a level, but rough road; and where such a pull does not exceed 20 or 30 yards at a time, he does not seem to be the worse for it. In pulls of 1 foot in 40, although three times the pull on a level, he will travel for a mile or more without shewing indication of fatigue. It may be remarked, also, that in all cases of *uphill* draught, the horse has his *own weight* to carry up, in addition to all that is contained in the lading. In the instances above stated, this is not taken into account. The horse is supposed to be walking on a level, as if he had reached the top of the hill, and from thence going forward

on a plain all the time that the carriage is ascending.

II. *Of Obstructions on common Roads.*

The difficulties presented to the draught in ascending steep places in roads, are little compared to the numerous obstructions that are continually interposed by small stones and gravel before the wheels, on even the best made roads. The draught in the most level road yet made, may be said to be a continual *uphill work*. Indeed, were it not from the velocity acquired by a carriage in motion, the obstructions presented by an intervening stone, of even a very small size, would be altogether unsurmountable. Fig. 2. Plate II. will better elucidate this remark.

The quadrant A, B, C, on a scale of one-fifth of an inch to an inch, represents the fore quarter of the under part of a wheel, 54 inches in height, rolling forward on the level road C, D. The perpendicular lines from the road, upwards to the circular line B, C, correspond in height to inches and parts of inches, as expressed by the numerical figures below. Supposing each of these lines to represent a stone, or other obstacle of the same height, placed in the way of the wheels, the circumstances resulting from such interruption would be as expressed in the 3 columns on the right; in which, Col. 1. shews the rate of ascent, as 1 foot in $4\frac{1}{2}$, when meeting with a 3-inch obstacle; Col. 2.

the number of times more difficult than drawing on a level, which in this instance is 19 times: Col. 3. shews the exertion required to overcome it: when the ordinary force required on a level is 80 lb., this requires 1520, and so of all the rest.

Such being the circumstances, it is not surprising that a horse on a railway should be able to draw so very much more than on the best made gravel road or causeway in the country. And as the very essence of the railway principle is to present a uniformly smooth track to the wheels, unincumbered with obstructions of any kind, therefore, the more that these circumstances are understood, the more general will be the desire to have railways extended in every quarter.

Fig. 3. Plate II. represents a section of what is called the *flanged* rail (or concave, as I have called it), in which a convex rimmed-wheel rolls along the flat surface *a* of the rail, whilst the upright side *b* prevents it from going off the track. As this flat surface is sunk on a level with (or, still more injudiciously, below) the horse path-way, it is apt to collect sand, mud, gravel, and not unfrequently small stones, from which a great interruption is given to the wheels in their progress; and a perpetual grinding both of wheels and rail occasioned, insomuch that, whilst the former are worn fast down, so also is the latter: this is represented by the curved dotted line below the letter *a*, where the wheels generally run, so as to give a receptacle to these obstructions, and

thus perpetuate the mischief. From these considerations the *edge* or convex rail has been introduced, of which, fig. 4. shews a cross section of one of the cast-metal edge-rails in pretty general use; and fig. 5. one of malleable iron, on which a flanged rimmed wheel rolls along the upper surface. This, in practice, is found to give an additional facility to the moving power, even to double or more, owing, doubtless, to the continued smoothness of the track, totally unincumbered with obstructions; for hardly even a grain of sand can find shelter on the top of them.

But independent of this, the shape alone of figs. 4. and 5., gives so much more sustaining power, that the cast-iron one (fig. 4.) can be formed equally strong with fig. 3., at two-thirds of the weight, and the malleable iron ones at one-third. This circumstance alone makes a saving in the original expence of about L. 240 a-mile, on the cast-metal edge-rail, and of about L. 460 on the malleable-iron one, after making allowance for the difference (which is not great) in the price of the metal. The rail fig. 3. weighs about 44 lb. per yard in length: Fig. 4. about 28 lb.; and the diagrams under fig. 5. weigh about 14 lb. each,—the one being simply a plain bar set on edge, 2 inches deep, and $\frac{2}{5}$ths of an inch thick; the other $2\frac{1}{2}$ inches deep, an inch broad at top, and tapered to $\frac{1}{5}$th of an inch at bottom. Of British iron, they are estimated at 11s. per cwt., delivered at the nearest sea-port.

IV. *Whether Cast-Iron or Malleable is preferable.*

As the great cause of the destruction of cast-metal rails, is their aptitude to *snap* or break; and as malleable iron is not liable to this at all, it ought, for this reason alone, to be preferred; for, besides the loss by breakage, which occasions a heavy daily expence in repairs, there is an interruption to the work in consequence, that happens more frequently than any person, uninformed on the subject, would be apt to conceive. But malleable iron is, in fact, from the outset, cheaper by about 2s. the yard on a single railway, compared even with the improved cast-iron edge-rail. Besides all this, the wheels glide more smoothly along a malleable rail. There are two reasons for this. 1*st*, There are *fewer joinings*. Cast-iron cannot well be trusted in pieces beyond a single yard in length; but confidence can be placed in malleable iron to any distance, and in practice, the bar is seldom less than 12 feet long. 2*d*, The *joining* itself is *fixed*, and made *immoveably* correct, by means of screw-bolts; whereas in cast-metal, however correctly the pieces may be *laid* at first, it is apt to alter; and where it alters but to the extent of a 20th part of an inch, or even less, it there presents an obstacle to the wheels, and so much does this prevail, that in them all there is, to a certain extent, a perpetual *grinding* and wearing both of wheels and rails, whilst even the waggons, kept ever in a tremulous motion, very perceptibly waste and get

out of shape. As to *oxydising*, or (if we may venture to use a common phrase to a common subject), the *rusting* to which malleable iron is supposed to be more liable than cast-iron, it must be such a mere shadow of difference as not to deserve notice. At least, where malleable iron has been used in rails, and *kept in use*, after ten years experience, no more rust is be seen upon it, than on the cast-metal in the same work, though both equally exposed to the weather. Another cause still of alarm has been endeavoured to be infused on the subject, namely, that malleable iron will not wear so long as cast-metal. Let it be so; but when it is adverted to, that, in the course of rolling along a single mile of rail, a wheel of 27 inches diameter (a common size), makes about 750 revolutions, and, therefore, must wear 750 times more than the rail itself, (which is touched upon only *once* in all this travelling), and that this wheel, (so far as regards wearing), although employed every day, lasts, nevertheless, one, two, three, or four years, and the wearing of the rail itself ought to last 750 times longer,—the alarm on this point, I should humbly hope, will subside. At all events, were the malleable iron-rails either to break or wear out of shape in the lapse of a few centuries, the metal would still be of nearly its original value, which cast-metal never is.

The sketch given in fig. 6., may perhaps serve to give an idea of the manner in which a malleable iron-rail is constructed; the bars are 12 feet long, fixed to each other, supported on stones, and at-

tached to them by screw-bolts at 3 feet from centre to centre. In laying the rails, it is essential that they be on the same level, and exactly parallel to each other; it is also no less essential that the centre and side-paths shall not rise higher than the stones on which the rails rest, to avoid all chance of mud, sand or gravel interfering with the rails, as will be understood by the cross section of a road given in fig. 7.

Fig. 8. shews the position of the stone *sleepers*, *s s s* with the resting plates *p p p*, and the bats *b h b* all firmly connected together by bolts and rivets; whilst the rail is laid level above the resting plate, and connected to the whole by screw-bolts.

V. *Of the Size of the Wheels.*

All wheels, whatever may be the height, have the same power, when rolling on the same level, provided (what does not seem to be generally known, or at least is very little attended to), that *the thickness* of the axle be in proportion to the *height* of the wheel. For instance, whatever power a wheel 36 inches in diameter has, when fitted on an axle 3 inches thick, the same power has a wheel 12 inches diameter, on an axle of 1 inch thick. Again, whatever power any wheel may have on any axle, it will have three times that power on an axle of one-third part of the thickness. This is a most important consideration; and, by attending to it, the power of wheels, compared with the present practice, might,

in most cases, be *doubled**; more especially on rail-roads, where very little additional strength can be required on account of *jolting;* for there no jolting should be allowed to exist. Even on carriages employed on the ordinary rough roads or causeways of the country, it may be suggested, without presuming too much, that considerable improvements might be made on their axles, by *lessening* their thickness, as they are almost universally *too thick within the bushes*; where they never break, nor is it possible almost they can.

There seems to be just three places where axles are apt to break, as represented in Plate II. Fig. 9. 1st, In the middle betwixt the two ends at *a*. This is naturally the *weakest* place, or rather the place where the greatest pressure applies. 2d, At *b b* where the *cannon*-nails go through the axle, by which the wheels are connected with the *body* of the cart or waggon. This place is *weakened* by the hole made, and frequently damaged in the making of it. 3d, At the shoulders *c c*, where the round ends within the bushes are connected with the rest of the

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* The common height of railway-wheels being about 27 inches, and the thickness or diameter of their axles being 2¼ inches, hence the wheels may be stated as having a power equal to 12, from being 12 times more in diameter. But were the diameter of the axles to be reduced to one inch, whilst the height of the wheels is continued at 27 inches, the power then of the wheels would be as 27, from being 27 times the diameter of the axles. That an axle of 1 inch thick is sufficiently strong for any railway-waggon shall be afterwards shewn.

axle, where it assumes a square form. There is generally or rather always, a *swelling* at this place in the axle, represented by the protuberances *d d*, and *e e*. These are meant to strengthen the axle, but are the very cause of making it break at the points *f f*; for the natural bending, previous to breaking, is suddenly checked, by the very unequal strength of the two adjacent parts, and transfers the *whole stress* upon the weakest of the two.

The remedies for all these are, 1*st*, For the middle part *a*, let the axle be *boxed* in wood, and a fillet of iron be applied, connecting the iron-axle here with the wood, in which it is embossed. 2*d*, For the cannon-nail holes *b b*, let there be none, but connect the axle to the cart by a strong band of iron, attaching both together firmly with screw-bolts. 3*d*, For the weakness at the shoulder points *c c*, let there be no swellings, but continue the tapering till it gets *within* the band that comes in place of the cannon-nail. The whole stress will then be divided equally along the whole length of the axle, betwixt the wheels, and not, as at present, concentrated on the joining betwixt the round and the square.

From not attending to these circumstances, axles are made thicker than necessary, and still not so strong as they might otherwise be, with the same weight of metal; insomuch that, from the excessive joltings the carriages are subjected to, from the rough state of ordinary roads, the axles frequently break notwithstanding. On railways, however, where

no such violent concussions can take place, it is preposterous in the extreme to continue to use such thick and weighty axles. Indeed it could not be credited that they are still used there, were not the fact so apparent. Nay, more, in some great works, there is little or no attention paid to have the axles correspond in thickness to the height of the respective wheels to which they are applied, as those of 18 inches in diameter have axles as thick as those of 6 feet high: in both cases, about $2\frac{1}{4}$ inches thick, at an average, within the bushes; in fact, as thick as the axles used in the heavy two-wheeled carts of Glasgow, which have, with a lading often extending to 2 tons, to encounter as rough jolting roads as perhaps are to be met with any where else in the kingdom. On the smooth railway, surely, such strength is not required; besides, a railway-waggon being mounted on four wheels, has *two axles to sustain the burden.* That circumstance, however, seems rarely to be taken into view.

In constructing and fitting axles, the only vulnerable place would be at the joining of the round ends to the square places at *c c*, where there is a small part unsupported, left open to view. This, however, in a well-fitted set of axles, ought not to exceed one-fourth of an inch in length. It must require an immense force to break a piece of iron $2\frac{1}{4}$ inches thick, and only a quarter of an inch long. Even *wood* can sustain a great weight in that situation. In the experiment represented in Plate II. Fig. 10., a small rod of fir-wood, one-fourth of an

inch square, required a weight of 72 lb. avoirdupois to break it, at the distance of one-fourth of an inch from the prop *p* where it was supported. Now, as it is a rule in mechanics, that, by *doubling* the *deepness* of the timber, the strength is increased *four-fold*, whilst, by doubling the *breadth* it only *doubles* its power; hence by an easy calculation, it may be demonstrated, that a rod of fir-wood, *an inch square*, would, in like circumstances, require 4608 lb. to break it.

The proportion that *iron* in point of *strength* bears to *fir* I am not informed of, nor have I been able from experiment to ascertain precisely the fact. But knowing that malleable iron, in point of *weight*, is very nearly fourteen times more than fir-timber, I should suppose that we shall not be far wrong in estimating its strength in the same ratio. So far, however, I know, that in an experiment made on a small rod of hammered iron, $\frac{1}{8}$th of an inch square, (and which, on the above estimate, should have broke when 126 lb. were suspended from it at $\frac{1}{4}$th of an inch from its support), it sustained 196 lb. without breaking; but allowing it to remain a few minutes, it bent downwards. But supposing it to have been no stronger than to have sustained 140 lb., it may from this be demonstrated, that an iron-axle, of a single inch in diameter, would sustain 57,344 lb., being upwards of 25 tons on each end, and as there are two axles on each railway-waggon, they would sustain in like proportion. In this calculation, the reduction of the strength, by reducing the square to a circle, is taken into the account.

On railways, therefore, where no jolting to any excess can take place, the axles, with every regard to safety, may be reduced to one inch (and less) in thickness, which, in general, may have an effect to double or triple the power of the wheels; or, in other words, enable the horse to draw twice or thrice the lading with equal ease, without augmenting the size of the wheels. The lower these are, the less liable are they to deviate from the direct track, and less liable to get out of shape.

VI. *Of the construction of Waggon Railway Wheels.*

The wheels at present in use are generally 27 inches high; some few, indeed, are as low as 18 inches, and some 30. They are formed wholly of cast-iron, and weigh from 1 cwt. to 1½ cwt. each, I mean those of 27 inches. Four of these go to a waggon, and, with their ponderous axles, weigh from 7 cwt. to 8 cwt., which, together with the body of the waggon, makes the vehicle seldom less than 14 cwt., while the lading is only from 26 cwt. to 32 cwt.; so that the waggon itself forms about a third part of the whole draught. The expence, or cost, is from L. 10 to L. 11 each.

For waggons on a railway that are calculated to carry such a burden, wheels and axles of that weight are not required. They might be constructed sufficiently strong at less than half of the weight, and, including the body, at little more than half of the

price. The wheels might be made of wood (still 27 inches high), whilst that part of them which comes in contact with the rail, might be shod with iron, and which could be renewed from time to time as required, without renewing the rest of the wheel. These would never snap, and would not be much liable to wear. Cast-iron wheels are very liable to snapping, and when any part of them wears down, or out of shape, the whole must be thrown aside.

VII. *Of the Form of the Waggon.*

In the present form of the coal-waggon, Fig. 11. Plate II., the whole lading operates like a *wedge*, with all its force, in bursting the sides of the waggon asunder, and is still more ruinous in the act of taking in, and of giving out, the coals, as these, in both cases, from the acquired velocity, rub and tear the deals to pieces. This has led to an expensive mode of lining them with plate-iron, which adds also to the weight, and increases the burden in the same proportion.

The form should rather be reversed,—making them broader at bottom than at top, as in Fig. 12. It is not necessary that the difference should be great. A single inch would be sufficient. The waggons, relieved of the constant pressure on their sides, would last double the time, without the expensive apparatus of iron *stay-props*, so copiously required in the present form. Thus, both in weight and in

price, there would be a great saving, whilst the waggon itself would be more durable.

VIII. *Of the Size of the Waggon.*

It was a great improvement at first the dividing of the 48 cwt. waggon into two of 24 cwt. each, and still further, when 4½ tons were found to be within the power of a horse to draw, to divide them into three waggons instead of two. Now that there seems to be a probability that double that lading or more is practicable, some people are of opinion, that the fewer waggons the whole is put into, the better, as concentrating the loading into less space on the railway. There is not much force in that reasoning, although it may be admitted to a certain extent. But the benefits to be derived from having the lading distributed in many waggons, rather than in few, are so many, that the system already introduced, of having as many waggons for as many tons, ought to be adhered to; for the *lighter* the lading is, the less *pressure* on the rails, the less *shaking*, and, in consequence, the less *wearing*, both of rail and waggon; and these advantages, together with the more *smoothly gliding along* of the whole train, should determine the question. But more than all these considerations,—the less weighty the lading is, the *smaller* may be the axles, which alone confers an advantage so very important as ought to set aside every objection that can be offered. At same time, it is capable of demonstration, that a horse can draw the whole lading, when laid on six or ten waggons,

with the same ease as if it were all laid upon one; and these six, or ten, waggons can be made for the same expence as the one, and not be heavier in all, than the single one alone.

IX. *Of the general Level of a Railway.*

The railways hitherto made, have been constructed either on a dead level, or on a uniform descent, to a certain point. This, in general, has been attended with a great expence, in cutting through rising grounds in some places, and filling up hollows in others; and, after all, the object, when attained, is to a certain extent, detrimental. For the horse in the draught, so far from deriving a continued advantage from it; on the contrary, in a long pull, the unvaried mode of draught, to which he is confined, becomes to him extremely irksome; and nothing but the shortness of the way, in any hitherto mode, makes it bearable. It is not from being *level* that the excellency of a railway is constituted; it is from the *smoothness* of the rail, along which the waggon glides. It is this that distinguishes, so very highly, the railway above the ordinary gravelled road, or laid causeway. These, in many instances, are quite level; but in none of them, nor in no part of them, is there such a facility afforded to the draught, as in the railway; for, in no other road yet known, is there such a degree of smoothness as the railway possesses.

Now, as it appears, from what is stated in a preceding section of the power of a horse in drawing,

that he can occasionally exert a much greater force than in his ordinary pace; and, far from being the worse for going occasionally uphill and downhill on moderate ascents and descents, he, on the contrary, feels a relief from the change; railways, therefore, as well as common roads, would not be the worse, but rather the better, that they were varied a little uphill and downhill, in their course from time to time; such as to the extent of 1 foot in 30 or 40. I do not say that we should go an inch out of the way to obtain this; but neither should we go a single inch out of the way to avoid it, provided that the distance so to be travelled is moderate, or not exceeding, it may be, a hundred yards or two at a time, and not occurring above twice or thrice in a mile. In a more moderate acclivity, of 1 foot in 70 or 80, the horse would not be oppressed, were the length of such to be a mile at a time, or more; it being always understood, that the horse is to be loaded in *moderation*, not to the utmost pitch he can move on a level; in which case he could not ascend a single foot uphill.

X. *Whether railway waggons can be constructed, so as to be adapted to go occasionally on ordinary roads, or on the streets of a Town?*

This does not seem to admit of much discussion. In the *form*, and in the *mode*, in which railway wheels are made, they are little fitted to encounter the roughness of an ordinary gravelled road, or the harsh unyielding surface of a street-causeway. Who-

ever will cast their eyes along the surface of either of these *ways*, will see so many inequalities in them, some rising above the level, and some sinking below it, that they must be convinced, that, even in those places where they are in the best order, a railway-wheel, if drawn along them, would be very liable to be either broken altogether, where made of cast-iron, or shaken out of shape, where made of wood. Even were the wheels to be made so strong as to withstand the rough usage, still the horse, in the draught, would be unable to accomplish more with them than in an ordinary cart. The advantage derived from the railway is owing to the peculiar construction (fitted to each other) of the rail and the wheels: a rough road is incompatible to these.

XI. *Whether Railways can be made to suit ordinary Carts, and other Carriages?*

Never till ordinary carts adopt the wheels peculiar to the railway, and which, again, are not adapted to an ordinary road.

XII. *Whether, on ordinary Roads, and Streets of a Town, there might not be made a Track suitable both to Railway-waggons and ordinary Carts, and other Carriages?*

This is certainly practicable to a great degree, so as to be equal, or nearly so, to the *flanged* railway, or where a convex-rimmed wheel rolls along a flat rail, and smooth surface. The thing is already accomplished, to a certain extent, upon one of the sides

of the common gravelled road, leading up from Glasgow to Port-Dundas. There, the road, in two particular places, was very steep, whilst lower down, it was nearly level; so that a horse could draw a lading there, that he could not draw up the hill at all; and, of course, the lading below was limited to what he could draw up the acclivity. Mr Baird, of the Shotts Iron-works, suggested a kind of railway of cast-iron, that obviated completely the difficulty, and has enabled ordinary carts now to draw, without any alteration in their structure, the same lading uphill that they can accomplish on the plain below. The device is simple. It consists merely in laying *flat plates of cast-iron*, in two regular lines, corresponding to the ordinary width of the wheel-track of common carts.

The ascent being 1 in 15, requires a power to overcome it more than six times what is required on a level, and yet a horse is frequently loaded with upwards of 2 tons on it, exclusive of the cart, which may be 8 or 10 cwt. more. This fact is corroborative of the theory laid down in the Table, page 77, so far as it goes.

Railways on this principle, might easily be constructed on every street, and every road; but more especially, would be highly beneficial on all steep pulls, of which there are many in the City of Edinburgh, both in the Old and New Town, as well as in other Towns and Roads in Scotland all over. In these situations, one side only (the left hand ascending) would require to be laid. Coming *down*-hill they are not wanted. It seems probable, that this

might be accomplished by applying *smooth-stone-pavement*, and of course at less expence. The steepest roads at present known in Scotland, from the *Cairn-a-mount* in Kincardineshire, to the old *Red-brae* of Soutra-hill in Lauderdale, might by such means be ascended, with *less labour*, by carriages, than is at present required on a dead level.

XIII. *Whether any mode of* package *would facilitate the draught?*

It is well ascertained, that on *carts* mounted on two wheels, and having the horse in the *shafts*, the lading (part of which is always made to bear upon the horse's back) can be so arranged as either to promote or to retard the draught. But, on a waggon mounted on four wheels, (and in which no part of the load can be made to bear on the back of the horse), it does not seem, from previous deduction, to be possible, either to promote or retard the draught, by any mode of packing, (though it is better for the waggon itself, that the lading should be arranged equally over the whole), and from a multitude of experiments that I have made, this turns out uniformly to be the fact. Whether the load was laid altogether to the fore part, or altogether to the hind part, or piled up wholly on the middle of the waggon, there was no perceptible difference in the quantum of power, required to move it along, whether on a level or up-hill. Nay, even in a case where the fore wheels were only one-half of the height of the hind wheels, it made no odds in the draught what end

went foremost,—whether the low or high wheels, whether up-hill, down-hill, or on a level.*

XIV. *Whether it affects the draught, that the Carriage be yoked near to the Horse, or at a distance?*

There is this difference betwixt drawing close at hand, and drawing by a lengthened rope or chain at a distance, that, in the latter case, there is an effort required to bring the rope or chain to the *full stretch*, before the impetus of the moving power reaches to the carriage to be drawn, and this effort requires to be continually kept up, in addition to the power required simply to draw the carriage. And this seems to be more in proportion as the distance is prolonged, than that distance (numerically) should seem to require. For example, it seems to

* Since writing the preceding Essay, it has occurred to me, that if, in a train of waggons, drawn by one horse, the foremost one were mounted on two wheels only, it would be quite practicable to make part of the lading bear on the horse's back; to do so, would *add to the power of the horse*, if done to a moderate extent; say 1 cwt. This would give an additional impetus to his draught, perhaps equal to all that weight itself, whilst this burden would affect, or retard, his travelling to no greater a degree than if he were mounted by a slender lad of 7 stone weight. Thus, if his ordinary exertion be equal, as supposed, to 80 lb., this weight of 112 lb. laid on his back, pretty far forward, would, without any additional exertion, (farther than as above noticed), encrease his impetus or moving power to 192; at least doubling his ordinary power, allowing part of it, as must be the fact, to be expended in *carrying* the hundred weight that is laid upon him.

require more than twenty times the effort to *taught* the rope, as it is called, when it is 20 feet long, than when it is 1 foot only *. I speak not with full confidence on this point, as the result of my experiments was not precisely defined; for although a rope at the distance of 20 feet, required a considerable weight to stretch it, yet at 1 foot and even 2 feet, the weight required to stretch was hardly perceptible; insomuch, that, in a string or train of waggons, connected with each other by intermediate ropes or chains, 1 or 2 feet only in length, the power required to draw one waggon is not perceptibly less than the power required to draw more, than merely in proportion to the *number* of waggons. The taughting of the connecting ropes or chains seems to require little or no additional impulse at all.

The results of the whole investigations on this subject are as under:

1. That the power of a horse in drawing, is estimated as equal to a weight of 80 lb. suspended over a pulley, but that he can exert himself occasionally to a much higher pitch, as in going up-hill in the many various acclivities, less or more, even to ten times as much, that still occur in most of the roads in the country, and that he is not the worse for

* It is hardly possible to straighten a track-rope of considerable length, nor does this seem necessary towards obtaining the full advantage of the horse's power, if his force be applied in the direction of the motion of the carriage.—*Editor of this Article.*

meeting with such in moderation from time to time, but rather the better, from the variety that this produces in his mode of draught.

2. That the obstructions arising to the draught, on even the most level roads, from gravel and small stones being interposed before the wheels, as these are occurring continually, are still more harassing to the horse.

3. That it is in being *smooth* more than in being *level*, that the excellency of railways consists, and which enables a horse to draw so very much more on a railway than on a common road.

4. That the *form* of the rail has been greatly improved, by adopting the *edge*-rail in place of the *flanged* or flat rail, even to doubling the effect,—a horse drawing 10 tons on the one as easy as 5 on the other.

5. That substituting *malleable* iron, instead of *cast* iron, offers a great additional improvement still; that it is also considerably cheaper, and less apt to get out of shape.

6. That the size of all wheels confers equal power on smooth surfaces, provided their axles bear the same proportion to the diameter of the wheels respectively.

7. That the present usual thickness of $2\frac{1}{4}$ inches of axle to a 27-inch high wheel on a railway, is preposterously too much; and that an axle of 1 inch thick, in this case, while it would give a power, compared to the other, as 27 is to 12, is itself so strong as would be able on a 4-wheeled waggon to bear more

than double the number of tons for every hundred weight with which it ever can be loaded.

8. That even the axle can be constructed on a stronger principle than at present, without encreasing its weight.

9. That constructing wheels of *wood* rather than of cast-metal, would be an improvement with respect to *price* and *durability*, but more especially with respect to *weight*.

10. That the form of the waggon would be improved by reversing the present mode, so far as to make it a small degree wider at bottom than at top; and that it might thus be made *lighter*, *cheaper*, and also more *durable*.

11. That small waggons are better adapted to railways than larger, whilst neither the weight, nor the rate of cost per ton, would be augmented from a greater number being required; but more than all, the axles might in consequence be made smaller, a circumstance of decided superiority.

12. That the general track of a railway, as well as that of a common road, is not the better of being made a dead level throughout, but may advantageously admit, where it occurs, of a gentle rising and falling alternately, to the no small relief of the horse in the draught, and greatly to the reduction of expence in forming the railway at the first.

13. That railway-waggons cannot well be constructed to suit an ordinary gravel road, or a street causeway.

14. That no railway adapted to its peculiar wag-

gons, can admit of carts or carriages of any other form to travel along it.

15. That ordinary roads and causeways may have a railway of a particular construction, formed on either side, for ordinary carts, as already exemplified on the steep pull up to Port-Dundas.

16. That no *packing* of the lading on 4-wheeled waggons can add to the power of the draught; at same time it is advisable to pack the lading as equally as possible, for the sake of the waggon itself.

17. That yoking the horse at a *considerable* distance from the waggon, by means of a *long* rope or chain, diminishes to a certain extent the power of the horse in the draught; yet, in a string or train of waggons, connected to each other at a *short* distance by short ropes or chains, there is little or no additional resistance from that circumstance given to the horse yoked at a short distance from the foremost waggon.

Lastly, as a corollary of the whole, by attending to all these circumstances, there seems to be every reason to infer, that railways may be constructed, so as to afford such a facility of carriage, as would make them supersede the lesser canals altogether, (or such as do not go from sea to sea), not only from being made at vastly less expence, kept up at less charge, and also not liable to interruptions from summer drought and winter frost, but from conveying goods (the main point in view) *at less expence.* Even, on a railway, *a diligence* or stage conveyance for passengers, inside or outside, may be con-

structed, that may rival a canal track-boat, affording as much accommodation, and making its journey with still greater celerity.

ESSAY BY MR GEORGE DOUGLAS.

The next Essay to be noticed is that of Mr George Douglas, mathematician in Edinburgh. It is here given in the form of an abstract taken from three Essays which he presented to the Society. Mr Douglas observes, that the art of road-making was probably known to the Chinese as far back as 2000 years, and that the partiality of this curious people for level roads, induced them to cut through mountains, and to cross extensive valleys, over one of which a stupendous arch has been thrown of no less than 600 feet. The next nation, in point of antiquity, noticed as remarkable for public works, is the Carthaginians, and from the vestiges which still remain of their aqueducts, he concludes that this great mercantile people must have been possessed of facilities for the removal of their goods to the interior country. In Britain, he thinks it not improbable that the aborigines may have had roads of an improved construction; but is of opinion, that, as an art, road-making was not introduced here till after the invasion by the Romans under Julius Cæsar, whose roads or causeways were strongly built with stone and cement, and tended generally towards a level. Mr Douglas observes, that the introduction

of wooden railways probably first commenced with the use of pit-coal, and thinks, from Whittaker's History of Manchester, that the inhabitants of that district were acquainted with its use prior to the time of the Romans, as some of the *boons* given to the Abbey of Peterborough before their time, consisted of 60 cart-loads of wood, and 12 of pit-coal. About the year 1216, Henry III. granted a charter to the town of Newcastle-upon-Tyne, to open mines for pit-coal; and in Charles I.'s time, who began to reign in the year 1625, coal was in common use in London. About the same period, waggons were constructed to pass along roads made for the purpose, which were named "Tram or Rail roads" and since that period they have been in a progressive state of improvement.

Mr Douglas has studied the construction of the various descriptions of roads, both of timber and iron, but, upon the whole, is inclined to give a preference to stone-railways, if the tracks were properly built, and supported through certain soft soils upon walls of masonry, the stones to be 8 or 9 inches deep, and about 4 inches in breadth of track, with a rise of like dimensions on each side. These would become smooth, and, among other advantages, be free from the inconveniences of the expansion of iron, or the waste and decay of timber.

One of the principal objects of the Society being to obtain a practical method for overcoming the natural inequalities of a line of road, Mr Douglas proposes to effect this by means of a wheel fitted with spokes, somewhat after the manner of a ship's

windlass, to which he gives the name of a "Revolving-lever."

"Before entering upon a description of this machine for raising the waggon to the higher level, I take a view of machines used for raising great weights. Those that are put in motion by the power of men, are for ordinary wrought by a crank. The perpendicular from the axis cannot conveniently be more than 18 inches; the handle by which it is wrought is at right angles to this; the axis upon which the crank turns has a pinion upon it, suppose of 6 inches diameter; this pinion may have 9 teeth 1 inch thick; let it act upon a wheel of 6 feet, which will have 113 teeth of the same dimensions with that of the pinion. The power of the crank over the pinion is 6 to 1; the axis of the 6-feet wheel being 1 foot, the power of the wheel over the axis is 6 to 1; the power combined is 36 to 1, deducting $\frac{1}{4}$ for friction, make 27 to 1; that is, a man working with the power of 1 cwt., acquires by the machine the power of raising 27 cwt. With respect to the time, the crank must revolve nearly 13 times to give the raising-wheel one revolution, which raises the weight 3 feet. It will not be found that the man working the crank can make above 12 revolutions in 1 minute, and at a medium not so much. Again, suppose that the wheel, upon whose axis the rope is rolled, be increased to 8 feet, the power of the crank to the pinion is 6 to 1, and of the wheel to its axis is 8 to 1; combined 48 to 1.; one-fourth deducted for fric-

tion is 36 to 1. Here the power is greatly increased, but the wheel of 8 feet diameter, must have 150 teeth to be of the same dimensions with the pinion, and the crank must be turned nearly 17 times round, to bring the wheel once round, or raise the weight 3 feet. Here what is gained in power is lost in time.

"To obviate this, I remove the crank, and substitute in its place a wheel, which I name a Revolving Lever, suppose of 6 feet in diameter, which works a pinion of 1 foot diameter; this pinion turns a wheel of 4 feet diameter, whose axis is 1 foot diameter. In this arrangement the lever to its pinion is a power of 6 to 1: and of the wheel to its axis is 4 to 1:, combined is 24 to 1; deducting $\frac{1}{4}$ for friction, is 18 to 1. With respect to the time in which the revolution of the lever is performed, I compute thus: a man can continue to walk for some hours at the rate of 3 miles per hour, that is 15,840 feet per hour, or 264 feet per minute: he can stretch his arms quicker than his feet, and to a greater extent. This I take from the observation of two men working at the long-saw; they generally make 12 strokes per minute, and work 3 or 4 hours on a stretch, excepting the time occupied in changing their draughts. But in working with the revolving-lever, he may be supposed, in bringing round the wheel, to make 3 feet at a pull; a wheel of 6 feet diameter is 18.449 feet in circumference; this he brings round at $6\frac{1}{3}$ pulls, but his travel is 18.449, not quite 19 feet, which is the 14th part of 264 feet or a minute's

travel; and for every four revolutions of the lever-wheel, the 4-feet wheel will be turned once round, thereby raising the weight 3 feet, and in much less time than by the crank. Suppose the lever-wheel to be increased to 12 feet, the pinion 1 foot, and raising-wheel 4 feet; the power of the lever-wheel to the pinion is as 12 to 1; and of the wheel to the axis 4 to 1; combined power 48 to 1; friction deducted, 36 to 1. With respect to the time, a wheel of 12 feet diameter is 37.999 in circumference; at a 3-feet pull he takes 12½ pulls to bring it round, and for every four turns of the lever-wheel the 4-feet wheel turns once round, raising the weight 3 feet as before, at every circumference of the lever-wheel: although the 12-feet wheel takes longer time than the 6-feet wheel, this is compensated by the greater execution.

"To render the proposed machine as simple as I can devise, I propose introducing an inclined plane, on which the load may be raised in three minutes, in place of increasing the diameter of the Revolving-lever; by the declivity allowed to the track, the loaded waggon drawn by one horse may be 3 tons. I propose to limit the machine thus: The lever wheel 6 feet, pinion 1 foot, and raising wheel 4 feet, gives only a result of 1 ton 4 cwt., the friction being taken off by the declivity allowed to the track; but this weight laid upon an inclined plane of a length six times the height to be raised, increases the main power to 7 tons 4 cwt.; but here friction must be allowed, by which he can only draw 5 tons 12 cwt. But the handles upon the lever-wheel are each 1 foot,

which makes the diameter 8 feet, and increases the power on the inclined plane to 9 tons 12 cwt.; friction deducted, to 7 tons 4 cwt. Here, as the power greatly exceeds the weight, it may be done in less time, or, if a 2-horse waggon come forward, it can be raised; but it may occur that a 4 or 6 horse waggon may come upon the road; in this case a long lever is provided, which may be applied to the wheel; suppose a lever of 12 feet, making the diameter 24 feet; the 4-feet wheel 4 to 1, makes 96 to 1; 96 cwt. is 4 tons 16 cwt., the power combined by the inclined plane is 28 tons 16 cwt.; deducting 7 tons 4 cwt. for friction, is 21 tons 12 cwt., which may be supposed the greatest weight that can come upon it: but this great weight shews the necessity of a firm foundation."

Mr Douglas farther notices as a precaution, that experiments made from models are apt to mislead, unless the principles are founded in science, and strictly attended to. As an instance of this, he observes, " I have broke a cord which supported 8 stone weight, by a single hair from the human head. I afterwards saw the model of such a machine extended to practice at a wharf upon the Thames; the weight raised, if calculated from the model, might have been considered to have been within the power of one man, or that two would have performed it with much ease; but, in this instance, a horse was employed, and he appeared to do the work with considerable difficulty."—" But, not only has models led to these deceptions, even the great Ar-

chimedes was misled by his models, when he said, speaking of the power of the lever, that allow him only a place to stand upon, he would move the whole globe of the earth. I have never observed that any philosopher has set him wrong in making such an assertion. I do not hesitate to say, that, although he had that station given him, that not only he, but he with 10,000 men to his assistance, could not have wrought the lever necessary to perform the work; and I suppose it would even have made Vulcan himself, and all his Cyclops, to sweat in forging it. Philosophers define a lever to be an inflexible line. I admit the definition; but in practice it must be rendered so by additional matter, and being thus rendered inflexible, so long as it is manageable, it answers the same purpose in practice that the philosopher's inflexible line does in theory."

In order that the masonry connected with this machine, in its most extended form, may be enabled to withstand the power of the revolving-lever, Mr Douglas proposes that the walls should be constructed by a system of dove-tailed courses, after the manner of the diagram in Plate II. Fig. 13., in which the whole of the stones are prepared and bound together in one mass.

Along with Mr Douglas's Essays, he has given Drawings to the Society of the Revolving-Lever-machine; but his description being sufficiently minute to enable the reader to follow his design, it is not thought necessary to engrave it. It may be understood to have much of the appearance of a portion

of a ship's windlass, with the hand-spokes inserted into it; or more strictly, to resemble the capstan with its levers in a vertical position.

ESSAY BY MR JOHN RUTHVEN.

The next Essay which we notice is that of Mr RUTHVEN, patentee for an improvement on the Printing-Press, and for the application of the crank and lever, as a "New method of procuring Mechanical Power."

After some preliminary observations, Mr Ruthven says, "I shall now come to the great desideratum, that of *surmounting elevations*. There may be two plans supposed; either a *perpendicular step*, or an *inclined plane*. To attain the object in view by the former, several contrivances have been projected; but, when it is considered that the load would probably not be less than 2 tons,—the strength of the machinery requisite for suspending such a weight, the loss of time in repeating the operation for every waggon, both in ascending and descending, and the consequent repetition of risk from accident, are, it may be supposed, sufficient to prevent its adoption. The latter, or Inclined Plane, possesses many and excellent advantages; for, exclusive of being much safer, the power can be more easily proportioned to the weight; the length of the inclination and elevation better adapted to particular circumstances, and the ascending and descending more easily attained."

"Having been very successful with an invention I brought forward some years ago, where an arrangement of the crank and lever were introduced for procuring power, I was inclined to make various experiments, with this apparatus, for taking waggons up an inclined plane. These were made on a rail-road, formed for the purpose by Mr Cadell of Cockenzie, the inclined plane being 100 feet long, and rising 1 foot in 10. After repeated trials, it was ascertained, that, by a more uniform application of the power, the object would be attained. It was not, however, till lately, that I succeeded with that modification of the power, which was found of such a nature that letters-patent have since been obtained for it, as a "New method for procuring Mechanical Power." Although extremely simple, it requires a little consideration to discover its properties. I shall therefore endeavour to give such an explanation as I trust will be understood; and this, I think, may be done before entering into a description of the accompanying model; as a correct idea of the *power* will render the application more easily conceived. In Plate II. Fig. 14. EE is a wheel, of which A is the true centre, and B the axis, on which the wheel turns; C is an axle and pinion, revolved by a winch-handle. DD is one side of the frame inclosing the wheel. By turning the axle C, the wheel EE is moved round; its axle B ascends, and continues doing so until it arrives at its greatest elongation from C, when it descends; and thus alternately. It resembles a wedge round the half of the wheel: the

points in contact form an acute angle, with a line drawn through the centres of B and C. These angles are constantly forming into straight lines in succession, and the power is produced and increases in an almost incalculable ratio, as the angles move into a perpendicular line,"—"being a succession of forces all terminating in points or lines, from which calculations can hardly be formed. From experiments that have been made, it is, however, computed, that one man will be able to take 10 tons up an elevation of 10 feet upon an inclined plane of 25 feet in length, in the course of from 6 to 8 minutes. The uniformity of the motion being, at the same time, kept up by the introduction of a second wheel with its apparatus, which are brought into action in the same manner as the first, and, while the one is descending, the other is ascending, thus keeping the same power continually in action."—"On a general examination of the mechanical part of this design, it will readily be ascertained how easily it can be modified to any elevation required, by merely altering the diameter of the wheel on which the chain connecting the waggons is coiled."

This Essay is accompanied by a very neat model of an inclined plane, with the crank and lever machine applied to a train of loaded waggons placed upon it. The crank-machine attached to the model is placed under the road-way at the top of the inclined plane; but Mr Ruthven observes, that, by making an offset with the rail-road at the top, the machinery may be placed on the surface of the ground.

For security in ascending with the waggons, he purposes to furnish each with two *stay-poles*. In descending, their velocity is to be regulated by a weight suspended on a double spiral wheel, which descends into a pit dug in the ground, corresponding to the length of the inclined plane. From this apparatus it is also proposed to gain power, as the weight may be doubled, or the space it moves through increased, according to circumstances. The weight upon the double spiral is made to change its power while revolving, gradually increasing as the waggons descend the inclined plane; and, in like manner, decreasing as they leave it;—thus accommodating the power to the different degrees of weight, and tending to accelerate the motion of the waggons up-hill, and *vice versa*.

Regarding the crank and lever, we have ample proofs of their beneficial application to the printing-press. But experience is still wanting to show, that Mr Ruthven's machine would be useful upon a railway to the extent alleged, although this may be worthy of further trial.

ESSAY BY MR JAMES DICKSON.

This Essay is from the Patentee for an engine applicable to various mechanical purposes, by means of hydrostatic pressure. Mr Dickson observes, as to the carriage of goods, that railways and canals have

the effect of shortening the distance between places. Railways, he conceives, should be made level, especially where the traffic is in opposite directions. The carriage and its load are to be lifted from one level to another by means of inclined planes or perpendicular ascents; to effect which, he justly observes, appears to be the chief difficulty in the formation of an efficient railway. In choosing between these, he remarks, "I certainly would give the preference to the latter, (perpendicular ascent). In the former, the risk of accident is incomparably greater; for were any part of the apparatus to give way when the loaded waggons are ascending the inclined plane, their recoil would be apt to carry destruction along on the level road. The friction would also be more, and the expence not much diminished. Since I conceive the perpendicular lift to be the least objectionable, I shall confine myself to the means by which I think this may be best effected. As it would be tedious to go into all the minutiæ, I shall only give the general principles, with a short descriptive account of the apparatus. The weight may be lifted by any of the impelling powers in use, viz. water, steam, animal power, or a winch-machine. The peculiarities of the situation will decide on the propriety of adopting any of these, and which ought to have the preference. Where water can be got in sufficient quantity, it certainly should be preferred; animal power or steam should have the next place; and wind, by being constantly employed, might raise

water, or condense air, to be used at pleasure; as, from the irregularity of the operation of the latter, it might be inconvenient to depend entirely upon it alone. In the event of steam being employed, it is unnecessary that the apparatus be more than a common boiler, sufficiently strong to bear a moderately high pressure, since it would be more convenient for every *Lock* to have a resident attendant. The additional expence in the case of steam would only be that of the coals.

"The plans for the locks may be divided into two, one for water, condensed air or steam; and one for animal power, wind, or a certain application of water. They may either be calculated for the principle of the cylinder and piston, or the rack and pinion. To the first may be applied water, condensed air, or steam; and to the second, a water-wheel, animal power, wind, or even a combination of the three, or any two of them, to either of the plans. Let A A, Fig. 1. Plate III. be the upper and lower levels of rail-road leading to and from a lock, which last is to be composed of four strong posts, marked B B B B, bound together at top and bottom, and of sufficient height to allow any lading to stand freely below it, while the carriage is on a level with the upper railway. After the attendant has placed the carriage or load upon the platform C C, he turns the cock D, and allows water to run into the bottom of the cylinder E, which, by pressing against the bottom of the piston, raises it to the top. The platform being connected to the piston-rod, will be lift-

ed at the same time. It will be evident from the figure, that the horse may either be lifted or not; and that the posts may be extended in length, to suit any number of waggons to be lifted at a time. It will also sufficiently appear, that steam from the boiler may be applied in the same manner; and further, that the lock-keeper, by attending to the water-wheel, animal or wind power, may pump up water, or condense air, to be applied in the same manner; but more instantaneously effective than the same power would have been, if only at work while the load was lifting. In the case here supposed, the average surface of the reservoir F is situate 5 feet above the level of the upper railway. A, is a weight equal to nearly 5 tons, to be lifted 20 feet, the diameter of the cylinder E being 3 feet. Thus a column of 25 feet would be pressing against the under side of the piston. When the weight is to be let down, the cock D is stopped, and G opened, which aperture must be placed so far down the pipe, that the weight of the platform, when descending empty, may press out the water in E."

To illustrate this more fully, Mr Dickson gives the following description of the apparatus. "The pressure of a column of water will be better understood by referring to Fig. 2., in which suppose AB a pipe of any diameter and height, and CD, the same height, but containing only a 20th part of the area. If AB contain a ton of water, CD will thus contain 1 cwt. when both are full.

If a piston be fitted to AB, with a weight less than a ton upon it, the whole of the water will not be pressed out of AB, although CD contains only 1 cwt. The same effect would take place if CD was of the same height as AB, although it only contained 1 lb. If a piston is put into CD, it would thus be converted into Bramah's press, which will lift the same weight, with less loss of time and less friction than any other method yet known. Another great advantage which this apparatus possesses, is the security of letting down the weight. By simply turning the cock G, you may have any degree of speed, with perfect safety to the operation."

It is further proposed by Mr Dickson, in his Essay, to effect the purpose of a perpendicular lift, by the application of a train of wheels and pinions, with friction-rollers, &c. to be worked by a crank, employed in elevating the platform with its load in a similar frame of timber with the hydrostatic apparatus, by means of a beam of wood, or a bar of metal, attached to it, with a rack or row of teeth on one side, fitted to work into the wheels. Connected with the foot or lower end of this rack, two counterpoising weights are attached by a connecting chain passing over pulleys, in such a manner as to keep the platform and its apparatus in equilibrium, thus producing a great relief to the acting force.

Regarding the application of the common cart to the purposes of a railway, Mr Dickson is of opinion, that, by forming a groove AA in the centre of the tread or rim of the wheel BB, agreeably to Fig. 3.,

it may be adapted, in a very simple manner, either to the purposes of the common road or railway.

ESSAY BY MR JAMES WALKER, LAURISTON.

Mr Walker has made several communications to the Highland Society, in which he approves of the edge-rail, as it has been found to answer so extremely well in practice. After a good deal of detail matter upon the construction of rails, waggons, and their wheels, and the practicability of accommodating the wheels of the common cart to railways, he describes a lock, or machine, by which loaded waggons may be made to surmount occasional elevations occurring in a tract of country, which may thereby be thrown into a line of road consisting of successive level tracks. The frame of this machine, and the platform for the load, with which it is accompanied, is to be elevated by a wheel-and-pinion apparatus, worked by the horses employed in tracking the waggons upon the railway, which are to be yoked in a kind of gin-machine. "I am well aware," he says, "that where any considerable height is to be attained, a lock is the cheapest method,—when it is considered what waste of land must occur, and how great a length of railway must be laid, in order to arrive at the same height, by means of a gradual acclivity; and also, if it is kept in view, that a very small rise will completely counteract any

horse's power with a heavy waggon-train." The model with which this communication is accompanied, being similar in principle to that alluded to in the following Essay, it seems unnecessary to give a figure of both; and as that now to be described works both with an ascending and descending apparatus at the same time, the one assisting the other, we shall make a delineation of it.

ESSAY BY MR JAMES WALKER, CARRON.

In this Essay, Mr Walker states that he has had his attention turned to the subject of railways, from the great benefit which the Carron Company have of late years derived from their introduction in the traffic connected with their extensive works, and he has accordingly directed his attention to various objects connected with this subject; but we only particularise his Lock or Machine for elevating waggons by a perpendicular lift. From his model, in the possession of the Society, a diagram is made; and its parts may be described as follows:

Fig. 1. Plate III. A A are the upper and lower levels of the railway; *b b b* the upright posts of the frame-work of the machinery; *c c* the upper and lower horizontal beams on a level with the railways; *d d d* the platform, and its frame, on which a waggon is placed; *e e e e* the corresponding platform and frame, which alternates with *d d d* in raising or

lowering the waggons. *f* and *g* are the suspending ropes or chains hooked to the tops of the platform frames; *h h* the drums or barrels, on which these ropes are coiled, only one of which is here seen; *i i* the barrel on which the horse-gin rope is coiled; *k k* the horse-lever-beam connected with the up-right-shaft *l*, supporting the barrels *m m*, on which the gin-ropes are alternately coiled and uncoiled in the process of raising and lowering the waggons; *o o o o o o* represent a section of the frame for supporting the working parts of the machine. The letters *p p* represent the supposed natural surface of the ground.

Fig. 5. A A A A the upper and lower railways; *c c c c* the upper horizontal beams supporting the rails over the frame-work; *d d* and *e e* the tops of the frames of the waggon-platforms; *h h* the two barrels with their axle *f f*, on which the suspending ropes of the platforms are coiled; *i i* the barrel on the same axle *f f*, with a division in its middle, on each side of which the gin-ropes are coiled; *l* the upright shaft, and *m* one of the barrels for the gin-ropes; *k k* the lever-beam for yoking the horse; *o o o o* the main upright posts supporting the machinery; *x x x x* the horse-track crossing the rail-road.

It is estimated, that, by means of this apparatus, fitted with a lever of 15 feet in length, and a barrel of 4 feet in diameter, an able horse will raise 7 tons about 6 feet perpendicularly in 3 minutes, and so in proportion for any other height.

The mode referred to in these figures, for overcoming inequalities in a line of railway, being

of pretty general application, may, under such modifications as the localities of the place suggest, prove practically useful where water cannot be obtained, and where the traffic may not be such as would afford the expence of steam.

ESSAY BY MR JAMES ALLAN.

The two Essays presented to the Society by Mr ALLAN, contain detailed accounts of his views regarding the construction and use of rail-roads. From the diversity of subjects which present themselves, he remarks, "to write an Essay adapted to the purpose of conveying commodities, under all circumstances, from one place to another,—to facilitate the means of loading carriages,—and to contrive a plan of wheels adapted to rail-roads, which also might be suitable for travelling upon ordinary roads, would require a very great deal of ingenuity and trouble."

In describing the component parts of a railway, Mr Allan seems to prefer the cast-iron edge-rail, and suggests the introduction of a notch of a particular kind in the end of the rails, and other necessary modes of keeping them in their places. But on this branch of the subject so much has already been done, and so various are the schemes followed for fixing rails, that it is difficult to say what is new, or what is really an improvement, without

the test of experience. In the same manner, this Essay enters much into minutiæ upon the best mode of constructing the turns and offsets, which unavoidably occur on a line of road, and various kinds of brakes or drags are given for rendering the passage of waggons more safe upon inclined planes. He also discusses at considerable length the subject, as to whether waggon-wheels should be fixed to the axle, and made to revolve with it, or whether they should be made, as is more common, to turn upon the axle; to the last, however, he gives a decided preference. He proposes to adapt the cart-wheel of the common road to the railway, by a groove in the rim of a broad wheel, fitted to receive an edge-rail, in a form similar to the diagram given in Fig. 3. Plate III. To avoid friction, he suggests that, instead of two pairs of wheels, only one might be employed, with a sort of small truck-wheel acting only occasionally, before and behind, so as to keep the waggons in a state of equilibrium.

Upon the great desideratum for surmounting the inequalities of a line of road, and dragging a train of waggons upon an inclined plane, he suggests various modifications of a wheel-and-pinion apparatus, to be worked by manual labour, but, upon the whole, he prefers the application of the block-tackle, for working which he makes use of the horse's power. According to the length of the inclined plane to be ascended, stones are to be placed in the line of the road at given distances for hooking the tackle successively, until the waggons attain

the summit. The writer of this Essay has been at much pains, and has displayed considerable ingenuity, in treating the subject, though the practical application is not always very obvious.

He seems to slide into a common error, when he concludes by observing, that " to decide whether rail-roads will prove beneficial or hurtful to a country, is a subject which will stand many arguments, there being various opinions and views on both sides of the question. Some say it will put a great many men out of employment, for if one man be allowed for every two horses upon the common road, it will only require one man and one horse on the railway for every six waggons, which may each contain a ton. Now, supposing 60,000 draught-horses be employed in the carriage of goods throughout the country at present, there would only be occasion for 10,000 horses on the introduction of a general railway-system. If we farther allow each horse upon an average to consume a stone of hay and a peck of corn per day, the former at 8d., and the latter at 10d., this would be a saving to the country of about 1,140,645 bolls of corn, and 50,000 stones of hay per annum, or L. 1,348,750, which would maintain all the 20,000 men that would be thrown idle, at the rate of L.48, 8s. 9d. per man per annum.

" Besides the saving of so much a year as mentioned above, there would be a great reduction in the price of the carriage of goods; for if there are 60,000 horses employed in this traffic, and the hire

of each horse be 8s. per day, the amount per annum would be about L. 600,000, supposing them only to be employed 250 days in the year. But were there only to be 10,000 horses employed, the hire would then be L. 100,000, which would reduce the price of carriage to a wonderful extent. The only evil, therefore, that might attend the system of rail-roads being generally introduced, would be the throwing so many men out of employment."

ESSAY BY MR JOHN FRASER.

The Essay now to be noticed is by Mr John Fraser, one of the Superintendants of the Wet Docks at Leith. After giving some historical account of the progress of rail-roads in the south, he briefly mentions the principal railways of Scotland, and states that Sir John Hope of Pinkie's railway, laid partly with cast iron and partly with malleable iron, and that of Edmondston, both in the neighbourhood of Edinburgh, cost from L. 800 to L. 1200 per mile.

He concludes his essay, by referring to a model of a plan for overcoming the inequalities of the road. The plan alluded to is simple in its construction, and capable of being put in practice upon a limited scale. It is, therefore, thought advisable to give a diagram of it in Fig. 6. Plate III; of which the following is a brief description. A A the upper and lower rail-

ways; *b b* part of the railway, forming a platform for a waggon, and also an inclined plane, connecting the upper and lower levels. This platform and inclined plane are moveable upon the joints *c c*, and so constructed, that when sufficiently elevated by the winch-machine, the waggon is readily transferred to the higher level, and *vice versa*; *d d* is a waggon on the platform; *e e e* the suspending rope or chain connecting the platform with the lever *f f*. The winch-machine *g g* is connected with the lever *f*, by a rope or chain *h*, employed in working the platform for the waggon; *i i* the fulcrum of the lever, is supported by the frame *k k k*.

ESSAY BY MR JOHN WOTHERSPOON.

In this Essay Mr WOTHERSPOON treats of a method for surmounting elevations,—on the advantages of a smooth surface for the use of the draught, and on the construction of railway carriages. For surmounting elevations, he proposes to have a train of machinery, consisting of wheels and pinions, which may be worked by the conductor of the waggons, who is to pull certain cords attached to them, and connected with the machinery, to which also, by a different arrangement, he may apply the horse's power. The machine is to be adapted to the common road, as well as a railway. It does not, however, appear very satisfactorily, either from the model or description, that this

application of machinery would be found very effective in practice. The observations regarding the advantages of a road with a smooth surface, and the construction of carriages used on railways, are of a general and obvious nature. Propositions for laying railway-tracks upon the common road, are conceived in this essay to be of incalculable value to a country, although only laid upon the occasional eminences which occur. On the acceleration of motion in carriages, it is observed, that those with four wheels in which the horse is not connected by trams or shafts, possess great advantages for the draught over those with two wheels. In the latter case, the horse is supposed to be continually in the act of bringing the carriage from a state of rest to motion, whereas the carriage with four wheels, to which the horse is yoked by traces, acquires an acceleration, which is said to render the draught less irksome, and much more easy for the horse. Mr Wotherspoon concludes with noticing, that the acceleration of motion, above alluded to, and the smoothness of the surface, are the chief advantages attending the railway system.

COMMUNICATION FROM MR JOHN MOORE *JUN.* of Bristol.

In this communication, Mr Moore proposes to subdivide roads into tracks, to be laid with iron in lengths of 3 feet, measuring 18 inches in breadth,

and $\frac{1}{2}$ inch in thickness; the lower side or bed to be convex, and the upper surface plain, without any flange or guard, to admit of carriages passing, without obstruction, from one set of tracks to another. He farther remarks, that stone might be used instead of iron. To enable the stones to sustain a considerable weight, their cross section ought not to be less than 18 inches square, and their length about 3 feet, laid in continuous lines similar to the tracks of an iron railway: he is of opinion, that stones of such dimensions, so imbedded in the road, that their upper surface may be on a level with it, will not be liable to be moved out of their places, by heavy weights passing over them; and as carriages will move smoothly on their surfaces, he thinks it will require much traffic to form them into irregularities and hollows; but in such a case, he adds, it will only be requisite to turn one of the other sides of the stones uppermost, and so on as they are found to require it.

To elevate carriages from one level to another, Mr Moore proposes to dig a well or pit at the top of the acclivity equal to its extent; and, by a system of weights, the loaded waggons are to be drawn up or let down in a gradual manner. If a stage or scaffold were erected over the pit, in height equal to one-half of the ascent of the inclined plane, then he observes that the pit may only be excavated to one-half of the depth above described.

For the improvement of carriages with two wheels, he suggests, that the whole body of the carriage

may be suspended much lower than is common, while the shafts of the cart may be so attached, that the horse would not have the load on his back to support; the wheels of the cart might then be of much larger diameter than is usual, by which means a greater load could be drawn on a carriage so constructed. From this description, it is presumed, that the large dray-cart with a bent axle is meant, the floor of which being suspended but a few inches clear of the ground, gives great facility to the loading and unloading of goods; but it is doubted if the labour to the horse will thereby be lessened.

MR JOHN BAIRD'S MODEL OF ROAD-TRACKS.

Among the models in the possession of the Highland Society, there is one from Mr John Baird of the Shotts Iron-works, consisting of two tracks of cast-iron, chiefly applicable to the improvement of the common road. In a memorandum which accompanies this model, Mr Baird states, that the tracks can be furnished for about L. 1, 5s. per lineal yard; that they are about 1 foot in breadth and 1½ inch in thickness, fixed into the check of a cast-iron sleeper or bed, in such a manner that they will neither be apt to be raised perpendicularly, nor sunk below the proper level, nor yet allowed to slip aside; while

being nearly flat, they admit of the wheels of a carriage getting off and on the tracks at pleasure.

A railway of this description was laid at Port-Dundas, near Glasgow, by Mr Baird, for the Forth and Clyde Canal Company, in the year 1816, upon an acclivity rising at the rate of 1 perpendicular to about 15 horizontal. Upon this track one horse took up a load of 3 tons upon a cart weighing 9 cwt., without any apparent difficulty, until he came to the top of the railway, and entered upon the common causeway; and although this was good, and the line of draught had now become easy, yet the animal could proceed no farther than to the extent of the cast-iron tracks. It is farther stated, that the carters upon this road all agree in saying that a horse had formerly as much difficulty in taking up 24 cwt. on the common causeway, as is now experienced with a load of 3 tons upon the railway-tracks.

Mr Menteith of Closeburn, who had long considered this subject, convinced of the practical application and great utility of these cart-tracks, if laid upon the numerous pulls or acclivities of the common roads of the country, visited the works at Shotts, to see their application; and considering this system to be particularly adapted to many of the roads in England, where the country is in general so completely formed and improved as to render any alteration of their lines of direction extremely difficult, suggested to Mr Baird the propriety of preparing a complete model of these tracks, for the Highland Society. A set of them was also

laid before some of the public bodies in the South; but as yet it is not understood that their use has become general; although, as we have seen by the experiment at Port-Dundas, where railway-tracks have now been in use for upwards of seven years, if laid upon the principal acclivities of an undulating line of road, they would enable a horse to take as much up-hill as he can draw upon a level on the common road.

Notes by Mr Stevenson, *in Reference to the preceding Essays on Railways.*

1*st*, I may remark, that an enlarged historical and descriptive account of the principal railways of the United Kingdom, would be a work of great utility in a country like Britain, depending so much upon its minerals, and the economical carriage of its manufactures; especially if drawn up by one professionally acquainted with the subject; who should state the expence, construction, and application of the works, together with the loads transported, and other particulars. These advantages were more or less in the contemplation of the Directors of the Highland Society, when they entered upon this investigation; and although, from the nature of these Essays, it was not possible to realize the full extent of benefit, yet much information has been collected; and one of the great objects of the Society will have been obtained, if the public attention shall thereby

be more particularly directed to the importance of the subject.

2d, In addition to what has been stated in the foregoing Essays, with regard to the origin of the rail-way system in this country, (which foreigners term the "British Roadway,") it may further be noticed, that there seems to be no doubt of the wooden-railway or tram-road having been first known, in practice, in the neighbourhood of Newcastle. The wooden rails came afterwards to be clad or covered with plates of iron; and this metal has ultimately become the only material used for this purpose. We have reason to believe that the first introduction of rails wholly of iron took place about 56 years since, or between 1766 and 1768.

I some years since visited the great Iron-works of Coalbrookdale, in Shropshire, where cast-iron was indisputably first applied to the construction of bridges; and, according to the information which I have been able to obtain, it was here also that railways of that material were first constructed. It appears from the books of this extensive and long-established company, that, between 5 and 6 tons of rails were cast on the 13th of November 1767, as an experiment, on the suggestion of Mr Reynolds, one of the partners. It further appears, that a Mr Curr, agent for the Duke of Norfolk's collieries in the neighbourhood of Sheffield, had soon afterwards an iron railway laid *under ground* at his Grace's works.

The first Public Railway Company seems to have

been instituted at Loughborough, in the year 1789, under the direction of the late Mr William Jessop. Here this eminent engineer introduced the Edge-rail, the upper surface of which was of an elliptical figure, with flanges upon the wheels to guide them upon the tracks of the road; for hitherto the Plate or broad rail, under various forms, is understood to have been solely in use.

About ten years afterwards Mr Benjamin Outram, an engineer of acknowledged ingenuity and merit, constructed the public railway of Little Eton, in Derbyshire. Here the plate-rail was adopted, with the flanges cast upon the rails, for the direction of the waggons, instead of having them upon the wheels, as is the case in the edge-railway. Here, also, the improvement of stone-props was introduced, instead of timber, for supporting the ends and joinings of the rails.

From this period, the plate-rail with stone-props seems to have become general, both in England and Wales; but experience, it is believed, has since shewn, that the edge-rail possesses many advantages over the plate or flat track. Malleable iron is every day coming more and more into use for edge-railways. It appears to have been first introduced, about the year 1815, at Lord Carlisle's coal-works on Tindal Fell, in Cumberland. Stone is another material which may be advantageously applied to railways, of which notice will afterwards be taken.

3d, With regard to the adaptation of the wheels of common carriages to rail-roads, and *vice versa* adapt-

ing the wheels of rail-ways to the common road, we may notice, that the writers of several of these Essays agree in recommending the forming of a rut or notch in the iron-rim of the common-cart-wheel, and thus fitting it for the edge-railway, as represented in Fig. 3. Plate III. But however desirable this accommodation of circumstances might be, it does not appear, in any view of the subject, to be very practicable. The loose description of fitting suited to the axle and wheel of the common road, would be ill adapted to the accuracy of which the railway is susceptible, and which, indeed, is essential to its best effects. It further appears, that this interchange is of less importance on the great scale; for, wherever a line of railway is introduced, the traffic of the respective districts will gradually, and with little inconveniency, be accommodated to the peculiarities of the railway. The chief article in which this transfer of wheels or carriages is most likely to be important, is coal, in connection with the supply of a great city. For this, the removal of the body of the waggon with its load, by means of a crane, from the railway-carriage to the common-cart, will, perhaps, under all circumstances, be found the most effective in practice.

4th, Admitting the utility of an interchange of the carriage to and from the common road, still, the great desideratum in the Railway-system, must doubtless lie in a convenient mode of lockage, for raising the waggons from one level to another, so as to admit, in an undulating tract of country, of the horse's power being uniformly exerted upon a level road.

On this branch of the subject, we refer to the various suggestions in the foregoing Essays, some of which will be found more or less applicable to the local situation of respective districts; for it is hardly to be expected that any single plan will be found to possess a universal character. We must call to our aid the use of various machines, and apply to them the powers of steam, water, wind, and animal labour, in a perpendicular lift, or upon an inclined plane, according to the local circumstances of the place.

In addition to the methods already suggested, I may notice the introduction of a wheel, varying in diameter, to a certain extent, according to the respective elevations met with upon the line of road, and constructed somewhat similar in its exterior to the common mill-wheel. Between the rims of this wheel the waggons are made conveniently to hook, and by its revolution they are lifted from one level to another, pretty much after the manner of the operation of a chain-pump. In another view of this mode, a revolving axle may be made the seat or saddle of an endless chain, to which the waggons are to be attached, and moved by machinery, as in the case of the wheel. These having been hooked upon the chain on the lower railway, as before noticed, are, by one operation, raised and laid upon the upper railway, in a very simple and efficient manner.

If, therefore, we suppose either of these machines erected on an inclined plane, or at a breast forming the connection between two railways on different levels, we thus see additional modes of accomplishing this desirable object. The apparatus thus briefly

described, may be worked by the power of the *track-horse*, or by any of the other forces above mentioned. The train of waggons to be elevated, and the time of performing the operation, must vary according to the circumstances or force of the acting power employed. It will also be obvious, that while a set of waggons is ascending upon one side of the wheel, or endless chain, another set upon the opposite side may be descending, as is the case in raising the coals from the pit at the Shotts Iron-Works, and at several other establishments. The same thing is also very well exemplified in the mode of raising the cotton to the hands of the spinners in Mr Owen's Works at Lanark.

Another method may here be noticed, for communicating with different levels, which was employed with great advantage, at one of the landing places on the Bell Rock, where, by means of it, blocks of stone were lifted out of the landing-craft, to the height of from 3 to 7 feet according to the state of the tide. This apparatus is termed a Sheer-crane, in my work upon the Bell Rock Light-house : it is delineated in Figs. 1 and 2 of Plate XI., and described at page 508 of that work. The sheer-crane is conveniently applicable to a lift of about 10 feet, and may be worked by the man himself, who conducts the train of waggons, or by means of his horse, according to the circumstances of the load. Its machinery consists of wheel and pinion work, adapted to the weight, and the power employed in lifting it.

This, as well as the foregoing plan, are modifications of the lever applied to the varying circum-

stances of the road; and the engineer will of course use his own discretion in these matters. What is here mainly in view, is to press this subject generally upon the attention of practical men. Surely, in the present advanced state of mechanics, it can never prove a very serious bar in designing a line of rail-road, that we have an apparatus to provide, which shall be capable of lifting a train of waggons *seriatim*, of from 5 to 8 in number, and weighing *in cumulo* from 8 to 10 tons; being the estimated working-load of an able horse, upon a well laid level railway. With such means within our reach, it is much to be regretted that the construction of level lines of railway is so often overlooked.

5th, I am therefore humbly of opinion, that every line of railway, on which goods are reciprocally carried both ways, should be formed upon One level, or laid out in a succession of level compartments, constructed with suitable apparatus for conveying loaded carriages from one level to another, either by means of animal power, water, or steam.

It is, however, a pretty generally received opinion, that a uniformly level road is more irksome and fatiguing to a horse, than one on which he travels *up and down hill*. When this subject was under my consideration, upon another occasion, I consulted a medical friend (Dr Barclay of Edinburgh), eminent for his knowledge in the science of *Comparative Anatomy*, as to the correctness of this opinion; and the answers to the queries which he obligingly allowed me to put, contain the following passages:

"My acquaintance with the muscles by no means

enables me to explain how a horse should be more fatigued by travelling on a road uniformly level, than by travelling over a like space upon one that crosses heights and hollows; but it is demonstrably a false idea, that muscles can alternately rest and come into motion in cases of this kind. The daily practice of ascending heights, it has been said, gives the animal *wind*, and enlarges the chest. It may also, with equal truth, be affirmed, that many horses lose their wind under this sort of training, and irrecoverably suffer from imprudent attempts to induce such a habit." In short, the Doctor ascribes much to prejudice, "originating with the man, continually in quest of variety, rather than the horse, who, consulting only his own ease, seems quite unconscious of Hogarth's Line of Beauty."—(*Report on the Edinburgh Railway.*)

6th, It may here be proper to notice, that, in the construction of inclined planes, works of masonry are not necessarily implied, any more than on the level road. If it be proposed to transport waggons with their loads in a horizontal position, up or down an inclined plane, this is conveniently effected by raising and supporting a platform upon the frame of a carriage mounted on wheels, on which the waggons are conveyed, and from which they are transferred, to the upper or lower railway, connected with the inclined plane. This method is generally adopted for removing loose earth in excavating canals, &c. But nowhere have we seen it more commodiously applied, than in transporting coal for Mr Crawshaw's extensive Iron-Works at Merthyr Tidvil in Wales.

7th, With regard to the line of direction for a railway, it is important, for the ease of the draught, that it should be straight; and, where a curve must unavoidably be introduced, the line of road should be made a tangent to it, and be formed upon a circle of as large a radius as can be conveniently procured. In an up-hill draught, a carriage may be represented as in the state of being continually lifted; so, in turning and winding about, even upon a level road or a canal, the carriage or boat may be conceived as being continually brought from a state of rest to motion, in a manner, perhaps, not less detrimental to the effective power of the horse, than the up-hill draught.

It has lately been proposed by Mr Palmer *, to construct railways of timber or iron, with only one track, that the friction may be diminished, and the road more easily constructed in a direct line, and upon one level. This single rail is to be supported upon upright standards of timber, metal, or walls of masonry, according to the localities of the district through which the road passes. The load is to be conveyed upon two wheels, placed the one before the other, in a receptacle or box suspended on each side of the rail. This mode admits of off-sets for branch-lines, by causing part of the rail to turn like a swing-bar or style-gate, with the load upon it. Having examined a short reach of Mr Palmer's new railway

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* See Description of a Railway upon a new principle, by Henry H. Palmer, member of the Institution of Civil Engineers, p. 60. with Plates. Published by J. Taylor, High Holborn, London, 1823.

in London, I was much pleased with it: it appears at once simple and ingenious. His descriptive account contains many useful remarks upon railways in general; and he discusses certain difficulties incident to the use of a single rail-track, in a very distinct and candid manner.

8th, The edge-rail (understood to have been originally introduced by the late eminent Mr Jessop), appears to be preferable, for every purpose, to the plate-rail; because, from the superior mode of applying the strength of the edge-rail, less weight of metal is required for its construction; while it is less liable to be impeded with dust or other adventitious matters; although the waggon-wheels are more subject to wear irregularly. With a view to obviate friction on the plate-rail, (still in pretty general use in Wales,) wheels with rims from an inch to half an inch in breadth have been employed; but these narrow-rimmed wheels are found to gutter and destroy the plate-rails. While, therefore, the edge-rail is apt to injure the broad-rimmed wheels, the rails are liable to be damaged by the narrow wheels; this last appears to be the greater evil of the two, both as to the ultimate expence, and the increased difficulty of the draught. Railway-tracks should in no case be laid at less than 4 feet apart: being no more space, than is required for the path of a horse, to travel on with freedom, and without injury to the props of the rails on each side.

9th, Regarding the description of materials to be used in the formation of railways, I have no hesitation in giving a decided preference to mal-

leable iron, formed into bars of from 12 to 20 feet in length, with flat sides and parallel edges; or in the simple state in which they commonly come from the rolling-mills of the manufacturer. The bars should be made of a depth and thickness suited to the weight to be carried, and to the numerous casualties of the road. An additional prop or two to the fathom of railway, will give more stability to the track than adding a little more breadth or depth of metal between the props, as is common in forming rails of cast-iron. The rails should be fixed into chairs or guides of iron, supported upon props of stone or cast-iron, placed at distances in no case exceeding three feet. The bars or rails should be connected with what is technically termed a clamp-joint, a species of connection in which the whole strength of the materials is preserved, the joints being fixed with rivets and washers, which are less liable than screws to unlock with a vibratory or tremulous motion; regard being also had, in the formation and fixing of the joint, to make provision for the expansion of the materials.

10*th*, The usual mode of laying railways, is to place the upper surfaces of the rails only a very little above the level of the horse-track. The consequence is, that the cresting or stuffing on each side is continually coming in contact with the wheels, to the great disadvantage of the draught. As these earthy matters cannot be supposed to be of the smallest use for keeping the rails in their places, it is much better to lay the rails so as to be wholly above the level of the horse-track. Such a construction gives addi-

tional facilities for drainage; and may be termed a Skeleton-railway, from the whole structure being exposed to view. This description of railway has been applied to practice with much advantage in several situations, particularly at Lord Elgin's extensive coal and lime works in Fifeshire.

11*th*, Railway waggons in Scotland are now generally used of a much smaller capacity than formerly; when three tons and upwards were conveyed upon four wheels. These heavy waggons shook the whole fabric of the road, and occasioned the rails to be made heavier, and the road, upon the whole, to be constructed at a much greater expence than seems necessary. The use of waggons of one ton load, or thereby, makes every thing work with far more advantage; we may instance the ease with which a waggon of this size is got upon the railway, when it accidentally gets off the track. Somewhat more friction is no doubt induced by the increased number of wheels, and some inconveniency is experienced from the greater length of the waggon-train. But these are much more than counterbalanced by the smaller axle which may be employed, and the general economy of the traffic. The body of the waggon may be advantageously made of plate-iron, oak-timber, or other hard wood. The waggons ought to stand rather low, and be of a broad construction; by this means they are more steady upon the road, especially in stormy weather.

12*th*, Various opinions exist with regard to the size of waggon-wheels, and their action. A wheel of from 15 to 18 inches in diameter is conve-

nient for the purposes of loading and unloading; and is advantageous for the yoke or line of draught with the ordinary height of the horse's shoulder. These become the chief points of consideration; the diameter of the wheel being of less importance upon the smooth surface of a railway, where obstacles like those on the common road are not to be met with. The track of the rims of the wheel for edge-rails should be made square or flat upon the tread, with a crest or flange upon the exterior side of it.

In regard to the action or motion of the wheel upon the axle, the more general way is to have the wheel to move upon it. Some, however, prefer fixing the wheel *dead* upon the axle, as in the case of the Irish car; while others, as at the slate-quarries of Penryn, have both the wheels and axles fitted for rotatory motion. To determine, from actual experiment upon the great scale, the preferable mode, would resolve an interesting problem in mechanics. It must, however, be kept in view, that the mere load to be supported upon a waggon of one or more tons burden, is not all that is to be provided for. The axle must be strengthened in all its parts, according to the nature of the traffic, and the unavoidable accidents of the road.

13*th*, The time is, perhaps, not very distant, when we shall see railways more frequently connected with the common road, as is already the case in some of the districts of Wales,—a system particularly adapted to the traffic between large towns. In some of the preceding Essays, notice is taken of stone-railways. Such a railway runs several miles along, or

is laid in conjunction with, a public road in Aberdeenshire. In the town of Nottingham, pieces of sandstone railways occur in narrow lanes and passages; and throughout the city of Milan, the narrow streets are said to be laid with tracks of marble. But both as described in theory and employed in practice, the stone railway is composed of blocks of several feet in length. From the difficulty of procuring these long stones, and of keeping them in their places, the road is rendered expensive, and is apt to become very incommodious upon the smallest shifting or distortion of the blocks. I have, therefore, had several experiments made with tracks of aisler or dressed causeway-stones nearly of common dimensions, though of a somewhat particular construction, which have been found to answer every purpose.

14*th*, From the interest which the Highland Society has always taken in improvements of a broad or general tendency, it may here be proper more particularly to notice a design, prepared some years since, for the main street of Linlithgow, (forming part of the great road leading from Edinburgh to Stirlingshire), which is to be constructed at the joint expence of the Magistrates of the borough and the Road Trustees of the county. By this plan, as will be seen from Figs. 1. and 2. Plate IV., I proposed to divide this street into two causewayed railways, by the tracks marked *a a a a a a a*, with compartments either of ruble-causeway, or small broken stones, between and on each side of them.

This system is applicable to all situations, upon

a greater or less scale, according to the width of the road and the extent of the thoroughfare. These tracks are capable of supporting the weight of any carriage, and may be laid with granite or any of the varieties of whinstone, (the greenstone of mineralogists), or even with particular kinds of sandstone. A foundation for these stones being properly prepared, they are laid or built the reverse way of the common causeway, as shewn at *a a a a* Fig. 2. They measure, say 12 or 14 inches in depth, 18 inches in breadth at the base, 12 inches at the top, and are about 8 inches in thickness, or in the *length-way* of the track, having in that direction their two sides dressed perpendicular or flat, so as to make compact or well jointed rows, as shewn in Fig. 1. On the top-side, the stones are also to be dressed and laid level for the wheel; it being intended that carriages should enter easily on and off the tracks. In this manner the stone-railway will form a durable road, possessing in a great measure, the advantages of the best aisler causeway and common road at a comparatively small expence; each pair of tracks in such situation as Edinburgh, being estimated only at 6s. per lineal yard. Between and upon each side of the stone-rails, as before noticed, ruble-causeway may be laid, as shewn at *b b b b b b*, Fig. 1. or small broken stones, technically termed road-metal, as shewn at *c c c c c c*, in Fig. 2.

15*th*, It would be too much for engineers to lay claim to the whole merit of the present good state of our public roads, as the trustees now every where possess in a high degree the taste for such improve-

ments. For a pretty long period, the roads have had a firm and proper bottoming, but we have only of late enjoyed the pleasures of the smooth surface; and these in conjunction, (for they must go hand in hand,) seem to produce what may justly be termed the perfection of road-making.

Yet it is not a little surprising to observe by how slow degrees even the most useful improvements are brought about. As a proof of this, it may be mentioned that, as far back as the year 1811, I had occasion to suggest the use of *small metal* in a specification for a piece of road in Kincardineshire; and in 1818, for another road in the county of Edinburgh; but even then the public mind was not prepared for it, and the plan was considered by much too expensive. It fortunately happened, however, that Lord Melville, in travelling through Somersetshire, saw the beneficial advantages of this system exemplified upon various roads in that district, under the direction of Mr Macadam; and it is perhaps not very generally known, that it was under his Lordship's influence that this system came to be introduced, in so short a period. So remarkably has the taste for smooth roads increased of late, that some of the principal streets of London, are now laid with small stones, in Mr Macadam's manner, instead of the usual paved causeway.

15*th*, One of the many advantages of a smooth carriage-way in a city, is the comparative state of quiet which accompanies it; an object so paramount with the Dutch, that they seldom use wheels to their

carriages in the streets of Amsterdam and Rotterdam. Upon noticing this singular custom to an eminent merchant of the former place, especially with regard to their hackney *coach-sledges,* he observed, among other things, that the noisy streets of England were quite intolerable to a Hollander.

In regard to laying the streets of a populous town with small stones, both the dust of summer, and the dirt of winter, it must be admitted, will prove great objections. As the means, therefore, of procuring the comforts of a smooth and durable city-road, at a comparatively small expence, it is proposed to lay stone-railways similar to those described under note 14th, in the principal streets of all populous towns, and also in such villages as happen to be situate upon the track of the principal highways throughout the kingdom.

In the present state of the public roads, the traveller passes smoothly along, till he reaches a city or village, when all at once he is hurled upon a rough and jolting road, distressing to himself, and annoying to the inhabitants of the respective places. To remedy the evils of the present system, in this respect, the use of causeway-tracks of aisler or dressed stones is suggested, on which the carriage-wheels might glide smoothly along. In point of economy, the causeway-rails would be greatly preferable to small broken stones, as the tracks may be conceived to be one uniform stratum, laid at an expence much less than a similar depth of broken stones.

EXPERIMENTS

WITH

SALT,

AS A MANURE, AND IN THE FEEDING OF LIVE-STOCK.

I. *Report by* Mr ANDREW ROBERTSON, *Farmer at Almond Myrehead, near Linlithgow; transmitted through the Right Honourable* Sir JOHN SINCLAIR, *Bart.*

Sect. 1.—*As a Manure.*

I deferred sending an account of my experiments with Salt, till they were completed, and the result fully ascertained, that I might neither deceive myself, nor be the means of misleading others. I have paid all the attention in my power to be as correct as possible.

This being a very dry season was rather against the trials; a wet season would probably have answered better; but the real state of this year's experiments is as follows.

Experiment, No. 1.—1*st November* 1818.—Sowed 28 lb. of marine salt on 3 falls of sandy land,

together with wheat, and ploughed both down. This is at the rate of 26 bushels per Scotch acre. The wheat for some weeks after *brairding* or appearing above ground, did not look so well as the rest of the field around it ; I think owing to the salt and the wheat *coming into immediate contact.* The crop was reaped on the 27th of August 1819, and produced at the rate of about 3 firlots per acre more than the rest around it. The whole field was much hurt by the mildew, and even where the salt was sown, it was not free from it, though not half so much injured as the rest. I think that it would have been better to have ploughed down the wheat, and harrowed in the salt, instead of sowing it with the wheat.*

Experiment, No. 2.—30*th March* 1819.—Sowed 21 lb. of rock-salt, or at the rate of 40 bushels per acre, on 1½ falls of excellent young clover and rye-grass, intended for hay. In a few days after, the clover in a great measure disappeared, and although there are some plants remaining, it is far from being like the rest of the field around it. I think that this has been an over-dose, and that the salt ought to have been mixed with earth, and used as a top dressing. I am inclined to be of opinion, from this experiment, that salt sown at this rate, or upwards, may be of great use to clean foul land from weeds, provided the salt is sown in time to let the war between it and the weeds be over, so that the grain

* It is ascertained, that salt may be sown with oat seed, this grain being covered with a husk; but it would seem that the seed of wheat is too tender to be mixed with salt.

may enter into a fertile field, and get peaceable possession.

Experiment, No. 3.—30*th March* 1819.—Sowed 7 acres of land with oats. One end of the ridges was of a sandy quality; the other half of the length of the ridges was more of a gravelly nature. The whole was half harrowed; then 25 bushels of rock-salt were sown on four ridges, or 146 falls, in the middle of the field; this was at the rate of 28 bushels per Scotch acre.

Experiment, No. 4.—Then sowed 9 lb. additional, on two falls at the end of one of the above four ridges, to make it at the rate of 40 bushels per acre.

Experiment, No. 5.—Sowed also 9 lb. on 4 falls at the end of another of the said four ridges, to make it at the rate of 34 bushels per acre. The salt was suffered to remain for three or four days, that it might be melted. It happened to get a gentle shower of rain in the interval; I then harrowed thoroughly the whole land that had been salted. The salt had an equal effect on both ends of the ridges. There was not any great difference between Nos. 3, 4, and 5. At any rate, the largest quantity did not seem to have done any harm. The first alteration we observed was, that not one-third part of *skellochs* or wild mustard were to be found on the four salted ridges as on the rest contiguous. When the oats appeared, the salted oats were observed to be a few days earlier, and more close on the ground. When cut down (23d August), the salted oats were more evenly ripened and whiter in the colour, and the stubbles

were also whiter. The produce of the four ridges was 29 threaves 18 sheaves, which gave 8 bolls 2 firlots and 2 pecks, Stirlingshire measure; and it weighed 15 stone 15 lb. and 4 ounces per boll.*

Experiment, No. 6.—The produce of four ridges that got no salt, two on each side of the salted ones, of the same length and breadth, was 27 threaves, and they yielded 6 bolls 3 firlots and 3 pecks, weighing 15 st. 7 lb. 8 oz. per boll, which is 7 lb. 12 oz. lighter than Nos. 3, 4, and 5.

Experiment, No. 7.—1*st April.*—Sowed 13½ bushels of salt on 9 ridges, or 1 acre 1 rood and 3 falls of land, after being harrowed, and prepared for flax-seed. The salt was dissolved before the seed was sown.

Experiment, No. 8.—8*th April*,—Sowed 7 bushels of salt, after sowing the flax-seed, on 7 ridges, or 1 acre and 20 falls. The end of one ridge got a double quantity of salt compared to the rest, and was in proportion better. There were in all 5 acres and 20 falls sown, and, according to my own opinion, and that of three other experienced farmers, whose names are annexed, No. 7 was one-fourth, and No. 8 one-fifth better than the rest of the ridges contiguous to them. The difference could be calculated in no other way; because, by watering in different holes, both the quantity and the quality are sometimes altered. I should have mentioned, that half of the length of the ridges consisted of strong clay;

* Reckoning 16 lb. to the stone, as common in many parts of Scotland; the English or avoirdupois being only 14 lb.—*Ed.*

the other half was more loamy. The salt had an equal effect on both descriptions of soil.*

Experiment, No. 9.—About the 1st of May an 8-acre field was dunged, at the rate of 40 solid yards per acre of moss and dung, in equal proportions, fermented properly according to Lord Meadowbank's method; and after being carefully and regularly spread, the whole field was ploughed, and every second furrow planted with potatoes. On the 8th of May 54 bushels of salt were sown on 3 acres in the middle portion of the field, the west side of which was rather sown the thickest. The salt lay melting for 14 days, and then the whole field got a single tine of the harrows, for three successive days. The middle portion that got the salt always appeared greener than the rest of the field; so much so, that after the potatoes were earthed up, that portion could easily be distinguished, at a mile's distance, when standing in the line of the rows. The crop was taken up about the 20th of October. The 3 Scotch acres that were salted produced 131 bolls and 3 firlots, Stirlingshire measure; 1½ acre on the east side, and the same quantity of land on the west side of the 3 salted acres were then taken up, and yielded only 120 bolls 2 firlots of the same measure. The balance in favour of the salted consequently was 11 bolls 1 firlot. My neighbours foretold that the potatoes produced on the salted land would be as black as peat

* It would appear that salt is always of use where the seed, like that of flax, is of an oily quality.

with the scab; but I am happy to state, that though they are a little scabbed, they are not so much injured as those where no salt had been applied. As this was only the fifth crop since the field had got 80 solid yards of shell-marl per Scotch acre, that may have occasioned the scabbiness. I do not believe, if lime had been applied at the same season of the year, that it would have had the same good effect.

Experiment, No. 10.—*14th May*.—Sowed 9 bushels of rock-salt on 5 ridges or 108 falls, that had been sown with barley and half harrowed; they were then fully harrowed. This was at the rate of 13 bushels per Scotch acre. The barley on these five ridges did not look so well after it came up, being more whitened in the colour than on the rest of the ridges on each side of them; and this continued until the first or second week of July, when they recovered, after getting some rain in the last week of June. When harvested, the produce was 8 threaves, yielding 6 bolls and 3 pecks of barley, weighing 18 stones and ½ lb. Dutch weight per boll, Stirlingshire measure.

Experiment, No. 11.—Five ridges contiguous to the above, and exactly the same length and breadth, gave just 5 bolls and 1 peck of the very same weight, but deficient in quantity to the amount of 1 boll and 2 pecks. Where the salt was applied, the barley was a shade whiter when cut down. The stubbles were considerably whiter, insomuch, that they could be distinguished at half a mile's distance, when in the line of the ridges.

Experiment, No. 12.—*4th June.*—Sowed 5 bushels of salt on 9 drills, before made up for turnips. Dunged 7 of these drills the same as the rest of the field, on each side of them. The other two got no dung; and one drill alongside of them got neither dung nor salt. It can just be said, that the salted drills were better than the unsalted, and that is all. Owing to the dry season, it was surprising to see how little difference there was between the drills that got no dung, and the rest quite contiguous that got 40 solid yards of well fermented moss and dung, in equal portions.

Experiment, No. 13.—*4th July.*—Watered a row of cabbage, and another of greens, with water strongly impregnated with salt, but cannot say that either the one or other was improved by it. Indeed neither crop was good, owing to the dryness of the season.

Profit and Loss on the Experiments above detailed with the Rock-Salt.

Paid for 4 tons of rock-salt, as per account, - - -	L. 4	0	0
Duty on do. as per permit, -	20	0	0
Freight from Liverpool, - -	4	4	0
Tolls, and other trifling expences,	0	3	0
Crushing and pounding it small, so as to go through a small riddle,	2	0	0
	L. 30	7	0

Sown as under.

Bushels.	Pounds.		Scotch. Acres.	Roods.	Falls.		L.	S.	D.
	21	on			1½	which nearly destroyed the grass.			
25	18			3	26	Oats, and gained 27 pecks, at 21s.	2	0	6
						62 lb. gain on the above, say	0	5	6
21			2	1	23	Lint, supposed to gain 10 st. at 12s.	6	0	0
54			3			Potatoes, gained 11¼ bolls at 6s.	3	7	6
13	8			2	28	Barley, the gain 18 pecks, worth	1	11	6
5					30	Turnips, profit but little, say	0	5	0
118	47		7		28½	Profit on a comparison of products calculated to be, which is about L.2 per Scots acre.	13	10	0

In regard to the expence of the salt, the 118 bushels 47 lb. employed in the above experiments, *duty included*, cost L. 21 : 2 : 6, so that owing to the duty there is a loss of L. 7 : 12 : 6. But as the salt, if free from duty, would have cost only L. 7:4:2, there would have been a clear profit, if the salt had been duty free, of L. 6 : 5 : 10, or about 18s. per acre, even in this year, though so unfavourable to such experiments.

The Declaration of three intelligent Farmers, certified by John Baird, Esq. a Justice of the Peace.

" *Gibstan, September* 1819.—This is to certify, That we, Walter Scott, farmer in Whitecross, Alexander Scott, farmer in Gibstan, and Henry Reid, farmer in Nicoltown, in presence of John Baird, Esq. of Manielmill, Justice of the Peace, in the shire of Stirling, having met at Almond Myrehead, and carefully examined the different crops on land that

had been manured with salt in spring last, on Andrew Robertson's farm; as likewise the crops of the same species on land on each side of them, which had not been salted: We were jointly of opinion, after inspecting the land on the 17th of August last, that there would be an addition of 2 bolls more oats per acre; between one-fourth and one-fifth more lint or flax; and 10 bolls Stirlingshire measure of more potatoes per acre, where the salt had been applied, than where it was not. The barley at that time did not seem so much discernible.

(Signed) "WALTER SCOTT.
ALEXANDER SCOTT.
HENRY REID.
JOHN BAIRD, *J. P.*"

Thus I have paid all the attention in my power during the short time since I got possession of the salt, in the making of these experiments. But still the following particulars remain to be ascertained.

1. What is the largest quantity that may be applied to the different soils with advantage?

2. Will salt raise the usual crop of turnips if properly managed, without the assistance of dung?

3. What is the best mode of using it as a top-dressing for grass-lands? and,

4. For what period of time will it produce benefit to the soil?

1st, With respect to the first question, I have sown by way of experiment from 8 to 40 bushels per acre at one ploughing, and none of these quantities seemed to be overdone. I therefore think,

that where the land is summer fallowed, it may be sown at three different ploughings, 20 bushels at each time. It will thus be properly melted and mixed with the soil before the seed be sown; and it will not be found an over-dose, more especially in deep soils. A man, with ordinary skill, if the ridges are 18 feet broad, can sow at the rate of 20 bushels per acre at two casts, or 30 at three, or 40 at four casts; the former can be done in one hour and a half by two men. There is no way that the salt can be so equally applied as sowing it by the hand, and it will be completely incorporated with the soil, if applied in time to be reduced before the grain is sown. A wheat firlot of riddled salt weighs 94 lb. English.

2d, With respect to the second question, I think, that if 20 bushels an acre were sown early in the season, and a few weeks after, when the salt was melted, it was ploughed down; if, in the month of March, other 20 bushels were sown and ploughed down in the same manner; and if, in April, 10 bushels more were left to melt as long as convenient, then ploughed down and thoroughly mixed by harrowing, that this would raise the usual crop of turnips (say from 30 to 35 tons per acre) without dung.

3d and 4th, With respect to the third and fourth questions I shall not attempt to discuss them at present. But I should engage to answer all these questions more perfectly, and others that may be proposed, if Government would give up the duty on a certain number of tons for making the experiments. I would pay the price of the salt and freight, with

every other expence myself; so that in this respect, all the ends of an experimental farm would be answered, without either trouble or expence to the public; and with a greater variety of soil and climate than any one farm can possess. For, in this case, besides my own farm, which consists of different soils, my brother has a rich low-lying farm or carse, about 5 miles distant from mine. I have likewise a friend who has a muirland farm 5 miles south from me, the half of which is strong clay. There is also a common, just now divided in my neighbourhood. In all these different situations, I would make any experiments that might be recommended to me, as I wish to be a useful member of society.

Any gentleman in this neighbourhood will give my character; and I shall give security, if required, that the whole salt *allowed duty free* shall be used for these agricultural purposes solely, under the penalty of double the amount of the present duty. This proves that I am confident of the utility of salt as a manure, though, perhaps, not in proportion to its present expence *.

If any quantity worth while is allowed, I shall get a machine erected to crush or bruise it with a horse, for it requires 10s. per ton to do it by the hand.

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* Since this was written the duty on Scotch Salt has been repealed, and that on English reduced from 15s. to 2s. per bushel.—Ed.

Sect. 2.—*In the Feeding of Live Stock.*

I was fully satisfied long ago respecting the benefit of giving salt, in moderate quantities, to horses and black cattle. It was a practice, about forty years ago, in this part of the country, to boil all the light or weak corn with a little chaff, and to give it to the work-horses for their supper. My father possessed a small farm at that time, and put a handful of salt every day in the copper, and boiled it with their food to keep the horses clear of the *bots*. It also cleared the skin. But when a peck of salt cost more than a peck of meal the practice was given up.

Some years ago I was feeding a large sow with potatoes, and although we gave her as many as she could eat, both in a raw state and boiled, she was making but little progress in fattening, when a neighbour, who was skilled in feeding stock, said, if I would send the sow to him, with the potatoes that were to be given her, he would take any bet that he would feed her in three or four weeks as fat as I could wish her. Accordingly, the sow was sent, and I did not see her for three weeks. She was so much improved in that time that I hardly knew her; and all that he gave her above what she got at home was some salt-herring brine among the potatoes.

Last winter I was afraid that a highland cow, kept among the rest in the wintering close, was rotten. In spring, when put to grass, she had a flux, or was what we call '*elfshot.*' I was advised by a person skilled in those matters, to give her half a

pound of scraped chalk, in sweet milk, to dry her up, and then give her a small handful of salt every night. She became very fond of the salt, and came to the place where she got it regularly every night. She became so tame at last, that she would lick the salt from my hand, and fed remarkably well. But for fear of her getting ill a second time, I sold her about a month ago, in good condition, to the butcher.

A handful of salt, mixed *with two pecks of potatoes*, the day before using them, in a great measure prevents cattle from being swelled with them. This method will also prevent turnips from swelling the cattle, when the potatoes do not agree with them *.

I have often washed feeding cattle with water strongly impregnated with salt. It prevents them from mangeing, and makes them content, and feed kindly.

When straw is very dry in the spring months, let it be strongly impregnated with salt, and both horses and cattle will devour it greedily, after it has lain for some hours in that state. This plan should be tried with pease and bean straw, as well as with that from corn.

The way that I consume my chaff and small or weak corn, is this: I have a large boiler of malleable iron, that boils a morning feed for 30 cattle at once, and at night they get turnips.

Last winter ½ boll of potatoes was boiled in water

* *Query*, Would it do the same with fresh clover ?

strongly salted, say to the amount of 4 or 5 lb. The potatoes, when boiled, were taken out from the boiler with a ribbed shovel, made on purpose, so as to leave the water in the boiler. The boiler was now filled half full of light corn or turnips, and then filled to the brim with water and chaff. After being once boiled, it keeps warm through the night for the morning feed to the cattle. In March last two young three-year old fillies were taken from the straw-yard, and put into the stables for spring work. In eight or ten days after they were put on this food they passed a number of worms, which we considered to be the effects of *the salted potatoes.*

The best way of salting hay, in my opinion, is, before cocking, to rake it in what are called *wind-rows*; then you strew upon it what quantity of salt you choose, the hay being green and damp to melt it. Then put it in cocks. It will require to stand a day longer in the cocks to dry, owing to the damp occasioned by the salt. To salt hay, in the act of stacking, although it is an advantage to the hay, yet it will not benefit its keeping, as the salt promotes damp.

A respectable gentleman in this neighbourhood, who formerly lived in Canada, and still has an estate there, told me, that in that country they consider salt almost as necessary for cattle as food; and that he himself has seen a score of black cattle around him waiting for it.

Some people argue, that if cattle have been accustomed to get salt regularly, they will not thrive

if the salt is taken from them. But if that should be the case, why not continue it?

ANDREW ROBERTSON.

ALMOND MYREHEAD,
27th Sept. and 29th Oct. 1819.

Remarks on MR ROBERTSON'S *Experiments, by* SIR JOHN SINCLAIR.

IT is impossible to peruse the above communication without admiring the zeal and public spirit and the anxiety to discover the truth, which it displays.

It evidently appears that a very great increase in a crop of oats, and a still greater one in flax, have been obtained by the use of salt; and that there is encouragement enough to repeat these experiments with the greatest probability of success. The plan of trying salt with summer fallows, sowing it at three different times, likewise promises to answer, either with wheat or barley, for in some parts of the kingdom they prefer barley to wheat after a fallow.

If the plan of raising a crop of turnips *without dung*, as suggested by Mr Robertson, by the means of sowing salt three times, were to answer, the advantage would be inestimable. The expence would be considerably less,—the quality of the root probably better,—and the dung now required for the turnip crop might be employed in giving fertility to poor soils.

The experiments with stock, so far as they go, are likewise valuable; in particular, the plan of salting straw, of different sorts, in spring; and of salting potatoes, so as to destroy worms in horses, &c., and to prevent or to cure other disorders to which stock are liable.

On the whole, it is impossible to peruse the report without hoping that Mr Robertson may receive the encouragement he desires (that of having salt duty free), to ascertain a number of important particulars connected with this inquiry.

JOHN SINCLAIR.

EDINBURGH, Oct. 1819.

APPENDIX by MR ANDREW ROBERTSON.

I am inclined to think, that salt will answer as a fermenter of earth and weeds, mixed together, so as to destroy the vegetative power of the weeds. The quantity I have tried is two yards square of earth and weeds, with three bushels of salt, which makes four solid yards, being three feet deep. It has fermented, but has not come up to blood-heat, the compound being very earthy: whether a lesser or greater quantity of salt would have brought the heat higher, I am not as yet able to determine; but, at all events, the vegetative power of the weeds will be destroyed better than if the compound be made up with slaked lime in place of salt.

The same quantity of moss and salt, made up in the same way, has never yet come up to a heat. I imagine that the moss was wet when made up, and the salt melting made it fully more so. But I am determined to try it still farther, as it will be a most essential object to have this point decided.

Since I wrote you last, the corn-land, No. 3, has been cross ploughed, preparatory to a green crop. My ploughman wishes me to believe that the four ridges that got the salt are more friable than the rest on each side of them. If salt has this effect on strong or stiff clay land, it will be an essential object.

The following is a contrast betwixt the expence of 30 bolls of Lime-shells, Linlithgowshire measure, and 60 bushels of Salt, *duty free*, with the distance of carriage from five to twenty miles.

30 Bolls of lime-shells, prime cost, say 2s. 6d. per boll, - -	L. 3 15 0
Carriage of do. for 5 miles, (charged higher than usual, the service not being ready, and waiting the turn of filling,) -	2 10 0
Slaking with water, and carting out on the ground, and spreading, say -	0 8 0
Expence for 5 miles,	L. 6 13 0
N. B.—To slake with earth will cost more.	
If carried other 5 miles farther, there being no lost time consequently, -	2 0 0
Expence for 10 miles,	L. 8 13 0
Carry forward,	L. 8 13 0

	L.	s.	d.
Brought forward,	L. 8	13	0
If carried 15 miles, or 5 miles farther, say	2	0	0
Expence for 15 miles,	L. 10	13	0
If carried still 5 miles farther, making 20 miles, - -	2	0	0
Total expence of lime, at 30 bolls per acre, brought 20 miles distance,	L. 12	13	0

	L.	s.	d.
Suppose 60 bushels of Salt, or $1\frac{1}{2}$ ton, delivered at Glasgow, Greenock, or Leith, at 30s. per ton,	L. 2	5	0
Bruising do., say - -	0	15	0
Carriage 5 miles of $1\frac{1}{2}$ tons, say -	0	7	0
Sowing on the ground, say -	0	2	6
Expence carried 5 miles,	L. 3	9	6
Carriage other 5 miles, being 10 miles distance, say (on account of their being no stoppage in loading) - -	0	6	0
Expence 10 miles distance,	L. 3	15	6
Carriage for other 5 miles, to make up 15 miles, - - -	0	6	0
Expence for 15 miles distance,	L. 4	1	6
Carriage for other 5 miles farther, -	0	6	0
Expence for 20 miles distance,	L. 4	7	6
Suppose it to be carried 20 miles farther,	1	3	0
Expence carried 40 miles,	L. 5	15	6

According to the above statement, an acre of land, the distance from lime 20 miles, limed at the rate of 30 bolls shells per acre, will cost - L. 12 13 0

An acre with salt, 60 bushels, the same distance, - -	4	7	6
Difference	L. 8	5	6

Whether the salt will last as long on the ground as lime, is a point not yet ascertained.

II.—*Report of Experiments with Rock-Salt as a Manure, upon the farm of Barnyards of Dalgety, Parish of Turriff, and county of Aberdeen, occupied by* THRIFT SCOTT.

1819, *April* 1.—2½ acres one year old grass, sown at the rate of 16 bushels per acre; 2 acres of ditto sown at 20 bushels per acre; ¼th acre of ditto, at 30 bushels per acre; 1 acre of two year-old ley, at 22 bushels; ½ acre sown grass, at 20 bushels per acre. The soil upon which the above proportions of salt were applied, is a deep rich black loam, upon a clay bottom.

April 22.—2 acres after turnip sown with barley and grass seeds, the salt sown at the same time with the grass-seeds, at 15 bushels per acre; 1 acre after turnip sown with oats, at 12 bushels; ¼th acre planted with potatoes, the salt put in the drill with the dung, at 18 bushels per acre: soil a thin light

gravel: $\frac{1}{4}$th acre six year old ley, at 20 bushels per acre; strong clay soil.

November 1.—$\frac{1}{2}$ acre of wheat, at 30 bushels per acre.

March 1. 1820.—$\frac{1}{2}$ acre of ditto, 28 bushels per acre; light clay soil.

Upon all these different soils and proportions of salt applied, no superiority whatever in the crops could be observed over those which got no salt. In autumn 1819, the two and three year old ley was ploughed for oats, and that crop this year, 1820, has derived no advantage from the salt application, neither has any of the other crops up to this time, (December 1820). On the morning after the salt was sown upon the grass-lands, there was a pretty hard frost, and the fields were slightly covered with snow. Where the salt was sprinkled, the grass was quite green, and the frost seemed to have had no effect.

" *Fyvie, 6th December* 1820.—I hereby certify, that Thrift Scott, tenant in Barnyards of Dalgety, is known to me as a man of honour and respectability, and I have therefore no doubt, that the several matters above detailed are strictly correct *.

" JAMES HAY, *J. P.*

" And Member of the Highland Society."

* Mr Scott made oath to the truth of the facts stated in his report; and the excellency of his general character was further

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III.—*Report of Experiments with Salt as a Manure; by* Mr Peter Christian. *Addressed to the Secretary to the Society.*

Mill of Forest, near Stonehaven,
6th November 1821.

Sir,—Having observed in the list of premiums to be given by the Highland Society of Scotland in the present year, one offered to the person "who shall make and report to the Society the best and most satisfactory experiments on the effects of salt as a manure in general," I beg leave to acquaint you, for the information of the Society, that I procured from Liverpool a quantity of refuse-salt mixed with ashes, in the proportion of three parts of the former to one of the latter, with which the following experiments have been made by me on this farm.

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certified by the Reverend Mr Moyes of Forglen, also a Member of the Society; and a certificate was produced to shew that Mr Scott had bought the salt with which the experiments were made. There is still, however, this important omission, that the lands salted were not inspected by practical men during the growth of the crops; nor does it appear that either measure or weight was used to ascertain the relative produce of the land subjected to the experiment, and of the rest of the fields.—Ed.

I.—*On a field of Potatoes, planted in drills, after Oats, following one year's grass, which had been laid down with Barley after Turnips fully dunged and limed; the soil a deep sandy loam.*

The land having received the necessary ploughings and harrowings, and being cleared of weeds, 60 falls were divided into four equal plots for the sake of varying the application of the salt.

Plot 1st having been drilled, salt was carefully scattered between the drills, at the rate of 32 bushels of the mixture to an acre; the potato sets were then planted in the intervals, and covered by splitting the drills.

On plot 2d, salt, at the rate of 16 bushels of the mixture per acre, was sown on the surface; after which the land was drilled and dunged in the intervals, at the rate of 14 tons of the best farm-yard dung per acre; and the potato-sets being then planted on the dung were covered as above.

Plot 3d having been drilled and manured with farm-yard dung, laid in the intervals at the same rate, salt in the proportion of 16 bushels of the mixture to an acre, was carefully sown on the dung, and the potato sets were deposited and covered.

Plot 4th having been drilled and dunged in the same manner and proportion, and the potato-sets planted and covered in the usual way, salt was sown on the surface of the covered drills, at the rate of 16 bushels of the mixture to an acre.

These operations were executed on the 2d of May,

and the rest of the field was planted the same day; farm-yard dung having been applied in the drills in the proportion already mentioned.

In plot 4th, the plants appeared above ground about a week earlier than those of the same kind of potato for which dung only was used, and the stems maintained a visible superiority of luxuriance during the season until they began to fade, in which they had a priority even greater than in springing. In plot 3d, the stems were later in appearing than those of the same potato to which dung alone was applied. In plot 2d, the plants were still longer in appearing than in the 3d; while in plot 1st, they were so backward that it was for some time apprehended the crop would entirely fail. At length, however, all the sets appeared to have sprung in all the divisions. In plot 1st, the stems were all along much stunted. Neither in the 2d nor 3d plots did they ever assume so much luxuriance as in the adjoining parts of the field where salt was not applied, and in all these three they were completely withered before the others had begun to decay. The four plots were drill-harrowed, hand-hoed, and earthed up along with the rest of the field. Plot 4th afterwards continued tolerably free from surface weeds. Plots 2d and 3d were but in a slight degree infested with them. But the drills in plot 1st were before harvest excessively over-run with grass and chickweed.

On the 27th of October, the produce of 12 square yards of each plot was ascertained by weight, and

compared with the crop produced in the same extent of the adjoining part of the field. The result was as follows:

I.—Small American Potato.

	Amsterdam lb.
Plot 1st salted in the drills, - -	14½
Plot 2d salted on the surface, and then drilled and dunged in the drills, - -	30½
Where dung only was used, - - -	41

II.—Purple Cluster.

Plot 3d dunged and salted in the drills, -	35
Plot 4th dunged in the drills, and salted on the surface when finished, - -	36
Where dung only was used, - -	42

III.—Long white Kidney.

Plot 1st salted in the drills, - -	11½
Plot 2d salted on the surface, and then drilled and dunged in the drills, - -	30

Owing to an accident, the comparative weight of the last mentioned variety where dung only was used, cannot be exactly reported; but from the appearance of the crop, it may warrantably be stated that it was not inferior in weight to the other varieties for which dung alone was applied; and, therefore, the superiority of the dunged land over the salted may be considered as great in this case as the others.

With regard to the quality of the crop, it was observed, that while in the other parts of the field the potatoes were full sized and mealy, those for

which salt was used were of unequal growth, many of them only of the size of marbles, and all of them waxy and comparatively unfit for the table.

II.—*On a field of Oats sown on a winter furrow after one year's grass, laid down with Barley, partly after Turnips and partly after naked Fallow.*

Three different parts of this field were subjected to an experiment on the 3d of May, just when the crop was fully *brairded.*

1*st*, On a strong clay, $\frac{1}{4}$th of an acre was salted, by sowing from the hand at the rate of 20 bushels of the mixture to an acre; $\frac{1}{4}$th of an acre, at the rate of 15 bushels, and $\frac{1}{4}$th of an acre, at the rate of 10 bushels; a ridge having, for the facility of comparison, been left unsalted between each of these divisions. This part of the field had been fallowed and fully dunged and limed in 1818.

2*dly*, On a rich sandy loam, two ridges, to the extent of $\frac{1}{8}$th of an acre, were salted in the same manner, at the rate of 18 bushels of the mixture to an acre. From a particular circumstance, these two ridges, though fully dunged for the turnips in 1818, got no lime, and it is believed had not been limed for many years before.

And, 3*dly*, On the same soil, where both lime and dung were abundantly applied in 1818, $\frac{1}{8}$th of an acre was salted, at the rate of 14 bushels of the mixture per acre.

The different salted plots were duly inspected from time to time, for the purpose of remarking any

effect that might have been produced by the application, but none was perceived, except that, in the mornings after heavy dews, and at other times after showers, the ground on which the salt was sown seemed to have attracted moisture more, and to retain it longer, than the adjoining ground. Persons conversant in agricultural matters were occasionally asked (some of them being informed of the purpose and others not), to compare the crop on the parts salted with what grew beside it; but neither from their opinion, from my own frequent inspections, nor by the observation of the person who manages my farm, and who entered zealously into the matter of the experiment, was I able to ascertain that the crop of oats was in any degree affected by the salt either in luxuriance or the time of ripening. The crop of the salted land was harvested at the same time with what grew beside it, and it was ascertained on thrashing equal parts of both, that the grain of each was exactly of the same weight per boll, while in point of quantity, the difference, though not material, was in favour of the land which was not salted.

This field had on a former occasion been much infested with grub, but last season none of it appeared, and there was, therefore, no opportunity of ascertaining the effects of the salt in preventing its ravages on the oat crop.

III.—*On a field of Barley sown out with Clover and Rye-grass seeds; the soil a good sandy loam.*

Of a part of this field which was last year completely dunged for turnips, but had not been limed

for a great many years, 60 falls were measured off immediately after the barley, clover, and rye-grass seeds were sown, and the land harrowed and rolled. Of these, 30 falls were then salted from the hand, in the proportion of 18 bushels of the mixture per acre, and 30 falls, at the rate of 12 bushels.

In another part of the field which was fully limed in 1816, and dunged for turnips last year, 40 falls were also, immediately after the barley and seeds were harrowed in and the land rolled, salted on the surface, at the rate of 16 bushels of the mixture to the acre.

Adjoining the last plot, the land had grown carrots last year without being dunged, and of it, after the barley was harrowed in, 20 falls were salted at the rate of 20 bushels of the mixture to an acre; three days after which clover seeds without rye-grass were sown upon the salt, and the land harrowed. The remainder of the carrot-land, was, for the sake of comparison, sown with barley and clover-seeds without either salt or dung.

The different salted plots in this field were carefully inspected from time to time, in the same manner as those in the field of oats; but no effects were detected on the crop of barley beyond what were noticed in the other. Between the salted and the unsalted parts there was no perceptible difference, either in the springing of the barley, in the subsequent growth of the plants, or in the luxuriance or ripening of the crop, and none appeared in the bulk when cut down. The season having been uncom-

monly dry, the clover and rye-grass seeds were backward in springing over the whole field. Since harvest they have, however, made good progress, and the plants of both are now abundant, where salt was not applied; but where it was used, there is an evident and material falling off; and to judge from present appearances, the grass-crop on the salted land will not exceed two-thirds of the weight of what is promised on the parts not salted. Even on the carrot-land, which, for experiment's sake, was deprived of the dung it should this season have received for the barley crop, the clover is the most abundant where the salt was not applied.

IV. *On Grass-Land.*

1*st*, On the 14th of May, 20 falls of a piece of unimproved sward in a grass field were measured off and sown with 2 bushels of the mixture.

Cattle had not then been admitted into the field, and they were kept off this plot till towards the end of June. A few days after the application, the salted sward assumed a brown appearance, which, on close inspection, was ascertained to proceed from withered plants of grass corroded by the salt. This wore gradually off, and in the course of two or three weeks the salted plot recovered its hue, but it could never be discovered that it derived any benefit from the application.

2*d*, On the 25th of June, part of an improved haugh, limed in 1816, which has been four years in grass, and in which cattle had been pastured to that

date, was railed off, and half an acre of it sown with 8 bushels of the mixture.

Here the effect of the salt was the same as on the unimproved sward. The grass was withered, and did not recover its verdure for several weeks, nor did it afterwards appear to derive any advantage from the application of the salt; on the contrary, the part salted did not, during the season, overtake in luxuriance those parts within the railing, on which no salt was bestowed.

3*d*, The same day, in a field of first year's grass, one acre of what had been depastured by cattle during the previous part of the season, was sown with 16 bushels of the mixture; and $\frac{1}{4}$th of an acre of what had been cut for soiling was sown with 4 bushels.

Both plots were saved for subsequent soiling, but on them the smallest visible effect was never produced by the salt. Either from the sward being here more open, or the plants more vigorous than in the older grass fields, no corrosion and withering was perceived, and between the salted and unsalted parts no difference of subsequent growth or luxuriance could be discovered.

V.—*On a field of Drilled Turnips.*

For this experiment a quantity of good black mould, dug from a bank of travelled earth, and exposed to the winter frosts, was, on the 7th of May, made into a compost with salt, in the proportion of one bushel of the latter to one cubic yard of the for-

mer, and being placed under cover they were intimately incorporated by frequent turnings.

On the 21st of June 70 falls of ground having been manured in the drills with excellent farm-yard dung, at the rate of 14 tons per acre, were sown by the turnip-machine with Norfolk globe, and then sown on the surface with the mixture of salt and ashes, in the proportion of 16 bushels to an acre. 20 falls, dunged in the same manner, were salted upon the dung in the drills at the same rate, the manure covered by splitting the drills, and the turnips then sown. 20 falls were salted in the drills at the same rate, without any dung, the salt covered and the turnips sown. 20 falls were manured in the drills with the above compost, at the rate of 16 bushels of salt and 16 cubic yards of earth to the acre, the manure covered, and the turnips sown. 20 falls were manured, with the proportion of the compost spread on the surface, which being ploughed in, the land was drilled, and the turnips sown. 10 falls were salted on the surface, at the rate of 16 bushels of salt and ashes per acre, after which the land was drilled, and the turnips sown; and, lastly, a portion of land was drilled and sown without either salt or dung. The rest of the field was manured with farm-yard dung, in the proportion already mentioned, of 14 tons per acre.

The turnips in the 70 falls salted *on the surface*, after being dunged and sown, were in springing much on a par with those in the unsalted land adjoining; they are equally luxuriant in tops, but inferior in

the size of roots; and on weighing three falls of each on the 3d instant, the difference was found to be exactly as 5 to 4 in favour of the crop on the unsalted land.

The division salted *in the drills* without dung may be stated as having totally failed of a crop. The few plants which have risen in it were late of appearing: the tops are stunted, and the roots of very diminutive size.

In the other four salted plots, the crop is also irregular and deficient, being inferior to that in the portion sown *without any manure*, and not half the weight of what was raised *with dung alone*. Of these four plots the crop is the best on that which was salted *upon the dung in the drills*, and on that which was salted *on the surface before drilling*; and it is the worst in the two for which *the compost of earth and salt was used*.

Such were the experiments made by me, which I beg you will communicate to the Society.

I have the honour to be, Sir, your very obedient humble servant,

PET. CHRISTIAN.

" Having, by actual inspection and otherwise, ascertained the accuracy of the facts stated in the foregoing Report, we do hereby certify the same.

" ROBERT W. DUFF.

" WILLIAM STEWART, *J. P.*

" *7th November* 1821."

IV.—*Report of Experiments made by* Lieutenant-General Dirom *of Mount-Annan, in the County of Dumfries, with Rock-Salt as a Manure, and as given to Live Stock.*

The salt laid down here, with the addition of 10s. for pounding and sifting it by hand, cost nearly L. 6, 10s. per ton.

Wheat.

No. 1.—*May* 12.—Sowed 12 stones upon 2 English statute acres, in four different parts of our fields in wheat, to try its efficacy in preventing mildew. No difference was observed, the whole of the crop being free of that disease this season.

The following experiments were made in part of a field of 20 statute acres at Bridekirk; the soil a clay-loam, on a dry bottom of freestone.

Turnips.

No. 2.—*May* 14.—Sowed 12 stones upon land prepared for turnips, 10 yards wide and 240 yards long. It was ploughed in autumn, harrowed and ploughed in May after receiving the salt. Weight of the crop 10 tons 1 cwt. 2 qrs. 12 lb., per English acre.

No. 3.—*June* 3.—Sowed 6 stones more upon one-half of the same ground, which was ploughed and harrowed again, and the turnips sown 15th June. Weight of the crop 10 tons 16 cwt. 8 lb.

The salt sown in No. 2., was at the rate of $24\frac{1}{4}$, and No. 3. at the rate of $48\frac{1}{2}$ stones to the English acre.

No. 4.—*June* 15.—Sowed 6 drills $2\frac{1}{2}$ feet wide and 240 yards long, with 15 stones salt. Crop per English acre 12 tons 1 cwt. 3 qrs. 24 lb.

No. 5.—*June* 15.—Sowed 6 drills as above, with 9 stones of salt. Crop 11 tons 4 cwt. 2 qrs. 24 lb.

In these two lots, the salt was sown upon the surface and drilled in, and the turnips sown the same day.

No. 6.—*May* 12.—Mixed 30 stones of salt with 24 cart-loads of 8 cwt. each, of moss or peat-earth. The compost, which was not expected to heat, was twice turned and well decomposed; and on the 22d July laid upon 12 drills $2\frac{1}{2}$ feet wide by 240 yards long. Crop 12 tons 1 cwt. 3 qrs. 24 lb. per English acre.

No. 7.—*May* 12.—Mixed 24 cart-loads of moss, with 6 cart-loads of dung; and after being heated and turned twice, it was laid upon 18 drills, the same as No. 6. Crop 12 tons 1 cwt. 3 qrs. 24 lb. per English acre.

No. 8.—*May* 13.—Mixed 24 cart-loads of moss with 36 Winchester bushels of lime in shells. It was turned twice, the moss-soil decomposed and laid upon 18 drills, 28th July, and the turnips sown the

same day. Crop 12 tons 24 lb. per English acre.

No. 9.—*July* 28.—Sowed 2 drills of the same length and breadth of turnips without manure. Crop 9 tons 10 cwt. 16 lb. per English acre.

No. 10.—*July* 28.—Sowed 12 drills of the same length and breadth, with 24 cart-loads of moss, which was twice turned, but did not heat. Crop 11 tons 2 cwt. 2 qrs. 24 lb. per English acre.

These nine experiments, from No. 2. to No. 10., were all tried in the same field, in which 14 acres were sown, dunged with farm-yard manure, at the rate of 5 tons to the acre. Crop 20 tons 3 cwt. 24 lb. per English acre.

Experiments in a field of 10 statute acres at Crosshill, a light dry soil.

No. 11.—*July* 18.—Sowed 6 drills upon land preparing for turnips, 2½ feet wide by 245 yards long, with 16 stones of salt. Crop 9 tons 18 cwt. 3 qrs 4. lb. per English acre.

No. 12.—*July* 18.—Sowed 6 drills 2½ feet by 235 yards, with 13 stones of salt. Crop 9 tons 12 cwt. 2 qrs. 4 lb. per English acre.

No. 13.—*July* 18.—Sowed 6 drills, 2½ feet by 160 yards, with 9 stones of salt. Crop 10 tons 16 cwt. 8 lb. per acre.

No. 14.—*July* 18.—Sowed 6 drills, 2½ feet wide by 140 yards long, with 7 stones of salt. Crop 9 tons 10 cwt. 19 lb. per English acre.

No. 15.—*July* 15.—Sowed 6 drills, 2½ feet wide

and 110 yards long, with 5 stones of salt. Crop 9 tons 8 cwt. 2 qrs. 14 lb. per English acre.

No. 16.—*July* 18.—Sowed 6 drills, 2½ feet wide and 90 yards long, with 4 stones salt. Crop 9 tons 7 cwt. 3 qrs. 8 lb. per English acre.

No. 17.—*July* 18.—Sowed 6 drills, 2½ feet wide and 90 yards long, without any manure. Crop 9 tons 1 cwt. 2 qrs.

Nine English statute acres of the same field, manured with farm-yard dung, 5 tons per acre, have produced at the rate of 25 tons 9 cwt. 3 qrs. 28 lb. per acre.

The result of the above experiments with salt as a manure for turnips, which were weighed this day, 13th November, shews that it has been attended with little or no benefit to the crop; and, of course, it will be discontinued in future.

Flax.

Four stones of salt, mixed with the same weight of linseed, produced a great crop; which is attributed to the season, as other crops in the neighbourhood were equally good without salt.

Pasture.

Sowed a quarter of an acre of one year old ley, and limed the same quantity of ground with 38 Winchester bushels of shell-lime. The salt and the lime seem to have greatly and equally improved

the pasture; the rest of the field having got no top dressing of any kind.

Live Stock.

Fourteen score of sheep, fed upon turnip last spring, got 2 stones of hay per day, with 4 lb. of salt melted in water, and sprinkled upon it. We had no death. The loss formerly used to be from one to two score.

We give our work-horses about 2 ounces per day each, and feeding pigs about an ounce each. Our cows in winter get 2 ounces each per day in steamed meat. The stock of every kind appear to thrive better since they got salt.

We have been in the practice of giving salt to our horses and pigs before we got the rock-salt; and, in stacking our hay, have, for many years, sprinkled salt upon it, in the proportion of about a stone to the 100 stone of hay (24 lb.), which helps to preserve it, and makes it better relished by the stock. We have continued the same proportion in using the rock-salt.

Garden Crops.

Salt has been used for raising onions upon beds a yard wide, at the rate of 3 ounces to the yard. The ground got no other manure, but was dunged and cropped with celery the preceding year. Salt was tried upon the same bed at the rate of a quart to the yard. Part of the same bed was tried without

any manure. The salt raised the best onions; and they were better where there was no manure than with soot.

Salt has been tried with cauliflower, Brussels sprouts, and cabbage, also at the rate of 3 ounces to the square yard, without any other manure, and has raised good crops and clean at the roots, which proves its efficacy in killing the worms. The same advantage was formerly obtained by using hot lime.

The experiments on the farm were conducted by the overseer or bailiff, W. Halliday; and in the garden by the gardener, R. Ross. They have, in my opinion, been made with great care, and are fairly reported.

ALEX. DIROM.

MOUNT-ANNAN,
13*th Nov.* 1819.

ESSAY

ON THE

THEORY OF IRRIGATION *.

By Mr James Lindsay, Land-Surveyor at Murdiestown, Lanarkshire.

In whatever light we consider irrigation, it must appear one of the greatest improvements in agriculture. If immediate gain be the object, it produces heavy crops of hay annually, besides rich pasture for cattle, in spring and in autumn, when, from its scarcity, this kind of food is rendered more valuable. If the improvement of land in tillage be the object, it is a source of manure; water being of itself sufficient to support, as well as communicate fertility, to those lands to which it is skilfully applied, without the aid of any other manure; so that the whole dung made from the hay-crop may be applied to other land in tillage.

* It has been thought expedient to omit some passages in this Essay, where the author was too diffuse: but care has been taken that the facts and reasoning should not be affected. —*Ed.*

The principles on which water operates in producing early vegetation and fertility, appear yet to be but imperfectly understood, which may have occasioned mistakes and disappointments. I have been told, that some of the farmers in the south of Scotland, considering it unprofitable, have already abandoned the practice. Even in England, where water-meadows have flourished in the greatest luxuriance for more than a century, the operating cause appears to remain one of the secrets of Nature. "For even now," says Mr Marshall, "when the reality of the improvement appears to be fully established, there seems to be no satisfactory theory to account for it; the warmth communicated by running water to the grass it flows over, is the best account for it the most enlightened in the art can give, of the good effects of running water on grass land."

The flattering accounts which appeared in many publications, of the advantages derived from irrigation, induced me, a few years ago, to travel over most of the water-meadows in the South of Scotland, and also over the principal water-meadows in several counties in the west of England, solely for the purpose of ascertaining the extent of that improvement, and the most approved methods of forming the meadows and applying the water.

As universal success in irrigating land cannot be looked for, till the principles on which it operates in producing such powerful effects are more generally understood, the intention of this essay is to endeavour to show how water operates on the soil in pro-

ducing early vegetation and fertility; and then to point out the soils to which it may be applied with the greatest advantage.

The early vegetation of water-meadows being the most striking improvement, deserves first to be mentioned, as the herbage generally appears on them five or six weeks earlier in spring than on land in the same situation, and of the same quality, when left to the common process of nature.

Food, moisture, and air, though indispensably necessary, are not sufficient of themselves to quicken the vegetative powers, and carry forward the growth of plants; a certain degree of heat is also required. Some plants require less heat than others to commence vegetation. The snow-drop and some other early plants, appear in full blossom, when the heat of the earth does not much exceed 32° of Fahrenheit, or the freezing point. Other plants require almost the whole of the summer's heat. Common saffron, in elevated situations, appears only in blossom about the end of September. Grass, and young plants of corn, seem to require a mid-day heat of 40° to 45° to commence vegetation; to ripen the seed requires a much higher temperature. Whatever the degree of heat may be, it will be readily granted that, without a certain degree, vegetation cannot take place. Seeds have not been known to germinate, nor plants to vegetate, so low as 32° of temperature. From these circumstances we may conclude, that irrigation increases, or rather maintains a higher

degree of temperature, in those lands to which it is applied during winter.

When the earth has received its greatest quantity of heat, and begins to emit it copiously in autumn, were any part of its surface covered with a bad conductor of heat, and allowed to remain covered through the following winter, the temperature under the cover would certainly be higher than where the surface was exposed to the winter's cold. Let us, therefore, inquire, what effect a covering of water would have in preserving the heat in the earth. Irrigation is commonly begun in October or November. The heat of the atmosphere at that time is very unequal. I shall here suppose it to be 45°. Whilst the atmosphere continued at that temperature, the water and meadow would be nearly of the same, probably a few degrees higher, as the heat absorbed by the earth in summer would rise by the carrying power of the water, and also by the conducting power of the materials of which the earth was composed. But the motion of heat in its ascent would be slow, as the carrying power of the water would be greatly weakened by being mixed with the soil and vegetables. Count Rumford found, that, by mixing eider-down, starch, or stewed apples, &c. with water, the motion of the heat was thereby greatly diminished. The changes of weather in autumn are frequently sudden: I shall suppose the heat of the atmosphere diminished from 45° to 33°. The internal heat of the earth, would continue to ascend and assist in keeping up the temperature of the

meadow and water, but it would be overpowered by the cold on the upper surface of the water, which would descend. The water would also lose part of its heat before it was carried on to the meadow, especially if it was mostly rain water, collected on the surface of the earth. The cold of the atmosphere in this case would descend by the carrying power of the water, more quickly than the heat of the earth ascended; consequently the surface of the meadow would be cooled down to 40°, but after it decreased to that temperature, any further reduction would take place very slowly. It is well known that matter in general expands when heated, and contracts when cooled: water follows this general law of matter, in all the degrees of heating and cooling, except between 32° and 40°. When the temperature falls below 40°, instead of contracting, it begins to expand, and continues to increase in bulk till it is frozen. In the change from fluidity to solidity, it increases to about one-tenth of its former bulk. Supposing the temperature of the atmosphere still to continue at 33°, and the water flowing over the meadow to be cooled down to 40°, the cold, as has been already observed, could not descend by the carrying power of the water; the specific gravity of water at 33°, the temperature of the water on the upper surface, being less than the specific gravity of water at 40°, which would be the temperature of the surface of the meadow. But the soil which contained the roots of the grass would probably be 2° or 3° above 40°, as the temperature of the earth, at a

certain depth, would be above 50°, which I suppose to be near the mean annual temperature of Britain.

Let us suppose the temperature at 80 feet under the surface remains stationary throughout the year at 50°, and that, in the end of summer, when the earth has received its greatest quantity of heat, the surface is 70°, then if the heat of the earth diminishes in a gradual ratio, at the depth of 20 feet the temperature would be 65°, at the depth of 40 feet 60°, at the depth of 60 feet 55°, and at the depth of 80 feet 50°. Let us again suppose, that, at the end of winter, when the surface of the earth has been for a considerable time at 32°; if it has continued so long at this temperature as to have allowed a gradual decrease to have taken place, to the depth of 80 feet, where it continues at 50°, then the temperature of the various depths would stand thus: At the surface 32°, 20 feet deep 36½°, 40 feet deep 41°, 60 feet deep 45½°, and at 80 feet deep 50°. Agreeably to this statement, the *mean* temperature of this mass of matter to the depth of 80 feet, would be at the end of summer 60°, and at the end of winter 41°, leaving a difference of 19°. But say that the surface of the earth, by irrigation, or a covering of any kind, has been preserved during the winter at 40°, then the mean temperature at the end of winter to the depth of 80 feet would be 45°, making a difference in all this mass of matter of only 4°. It deserves to be remarked, that, to increase the mean temperature of the earth to the depth of 80 feet, agreeably to the above

calculation, from 41° to 60° or 19°, requires one-half of the year, or 182½ days. But when the earth is preserved 4° higher in spring, making the difference only 15°,—in the same ratio, to raise the temperature from 45° to 60°, would require only about 144 days, making a difference of 38½ days; which is found, by experience, in ordinary seasons, to be near the space of time that vegetation begins to appear on water-meadows, before it appears on land of the same description when left to nature, or without a covering in winter.

There are other circumstances attending irrigation, which assist in keeping up the temperature of the earth. I have supposed in the above, that the water is brought on to the meadow at 40° of temperature, but the water of large springs (from the sides of mountains) which flow, before their outlet, so far under the surface, as not to be affected by the changes of temperature in the atmosphere, in summer or in winter, may be carried on to meadows adjoining the mountains, at a degree of heat very little below the mean annual temperature of the latitude in which they are situated. Hence the beautiful verdure which may be observed at a great distance in the course of these springs throughout the winter. The water of deep lakes also maintains a temperature considerably higher than the surface of the earth in winter, and might be carried on meadows, in many situations. From the carrying power of water, and property possessed by it of expanding when cooled under 40°, the whole body of the

water of lakes must be cooled to that degree before it begins to freeze. Loch Ness, in the north of Scotland, from its great depth, seldom or never freezes, which shows that the mean temperature of the water does not fall below 40°, except in very severe winters. The water of deep rivers usually continues near this temperature, though covered with ice. Although water may be carried on meadows between 40° and 50° of temperature in the time of frost, yet if the frost is severe, it will be cooled down to 32°, and the meadow covered with ice. But ice, though a cold covering, is better than none, as it prevents the heat from being carried off from the earth so quickly as when the surface is exposed to the open air.

The colds in Britain are commonly moderate, when compared with the colds in the same latitude on the Continent. The large collection of water around this Island, by giving out part of the heat communicated to it in summer, assists in keeping up the temperature of the atmosphere in winter. The greatest degree of cold I have seen recorded, was observed by Mr Wilson at Glasgow in 1780; in the thermometer, when laid on the snow, the mercury sunk 25° below zero. Mr Middleton mentions in his Agricultural Report of Middlesex, that, on the 24th January 1795, it fell 6° below zero. Such intense colds always take place when the ground is covered with snow; ice and snow being non-conductors of heat. The heat of the earth is entirely prevented by them from ri-

sing, to assist in keeping up the temperature of the atmosphere. In the above case, when the mercury fell 25° below 0°, the upper surface of the snow would have been 57° colder than the surface of the earth; and we know that the motion of heat from one body to another in contact, is quicker in proportion to the difference of their temperature. The temperature of the earth's surface at that time, under the snow, would be 32°, so that the heat would not be carried off so quickly as in the mildest frost, when deprived of a covering.

When any part of the earth's surface is exposed, the current of air must carry off the heat quicker, in proportion to the decrease of temperature in the atmosphere, and increase of the velocity of the current of air. Hence we feel the cold more sensibly, as the heat is carried quicker from the human body, when the thermometer indicates a temperature of 40°, or 45°, and the current of air is brisk, than when the mercury falls to 25°, and the current of air is scarcely felt. Hence the benefits of plantations, or any other kind of shelter, for promoting vegetation, as they prevent, or rather elevate, the current of air, so that the solar rays penetrate more freely into the earth; and from the same cause the heat is not so quickly carried off in cold weather, For we know from experience, that when pasture fields are left rough in autumn, and not pastured in winter, the vegetation of their herbage appears much earlier in the following spring, than when they are eaten bare by cattle; and consequently, in a

great measure, deprived of a covering. It has been often observed, that a covering of snow operates on the soil as a kind of manure, and that the land always produces a better crop the following season, than it would have yielded had it been left bare and exposed to the weather. There is no doubt but that snow contains enriching matter as well as rain water, which I shall have occasion to mention. But I believe, that the effect produced may be imputed more to shelter from the washing rains, and the heat preserved in the earth, by being shut up from the circulation of the air in winter, which must tend to forward vegetation in the spring, than from the fertilizing qualities of the snow.

Other circumstances might be mentioned attending irrigation, some of which tend to increase, others to lessen, the temperature of the meadow. But considering what has been advanced sufficient to account for the early vegetation of water-meadows, I shall now proceed to point out how water encreases the fertility of those soils to which it is applied.

To discuss this part of the subject in a satisfactory manner, the mind naturally suggests that it would be necessary, first, to show what is the food of plants, then to point out how water operates in preparing and supplying the plants with that food. But, as it would extend this essay too much, to mention the opinions or conjectures formed on this subject, all I shall ask for my present purpose is to be allowed, what every farmer will readily grant, that all vegetable and animal substances, in a certain state of putrefaction, contain the principal ingredients of the food of plants.

The meliorating effects of water impregnated with fertilising substances, when used in irrigation, are obvious; but as there are many answerable situations for water-meadows, where water enriched by flowing through fertile countries, manufacturing towns, &c. cannot be obtained, I shall first try to show the effects of water on the soil, supposing it divested of all these fertilising substances, although there is no such thing in nature.

If pure water is used in irrigation, it is evident that its fertilising effects must depend chiefly, if not entirely, on its operation on the soil, or on those substances already contained in the soil. As the decay of vegetables takes place gradually, more or less, according to circumstances, in every soil, particularly in old grass-land, we find large quantities in different stages of decay. When the quantity of moisture and heat in the earth are answerable, the putrefaction of those vegetables is carried forward, till they become soluble in water, and nutritive food for a new race of plants.

Besides supplying the moisture necessary for promoting putrefaction, water, when long applied, or even in a few days in warm weather, produces fermentation in the soil. This is known by a white scum rising to the surface, and if the water is not taken off the meadow when the scum appears, it continues to increase, the particles unite and become a tough substance *, which falls down on the herbage, and

* The appearance here described is frequently produced by the growth of different species of Conferva.—Ed.

prevents its growth for that season. This fermentation, though soon stopt, must prove favourable to the decomposition of the crude vegetable and animal matter, and also improve the texture of the soil. Water is found to destroy some plants, and to increase the number and promote the growth of others; fortunately they are the plants of least value for herbage to which the water proves noxious.

The decay of some plants and the increase of others, I do not impute altogether to the immediate effects of water; the improvement that takes place in the quality and texture of the soil must have considerable influence. This I am the more inclined to suppose, as the change does not take place to the full extent the first year the water is applied, but gradually, and the herbage continues to improve in quality for a great number of years. We also experience a change of plants after drainage, tillage, the application of lime, putrescent manure, and every improvement.

The effects of pure water when used in irrigation, appear to me in some instances to resemble the effects produced by lime. Does quick-lime, by its caustic qualities, or, after it becomes effete, by its putrefactive qualities, dissolve the crude vegetable and animal substances contained in the soil? Water, by producing fermentation and putrefaction, does the same. Does lime, by its particles, which are more retentive of moisture than sand, and less so than clay, improve the texture of both these soils, and by the expansion of its particles, when

moistened, perhaps produce some mechanical changes in the division and arrangement of the particles of the soil? Water likewise improves the texture of soils by fermentation, and by expansion when frozen. Every farmer knows that land is much more easily ploughed and harrowed after a severe frost, than when the frost does not penetrate into the earth. Perhaps some of them have not attended to the cause. Land always contains a considerable portion of water, in contact with the particles of the soil. The particles of water when frozen increase in bulk, which places the particles of the soil at greater distances, and they do not regain their former positions for a considerable time after the frost ceases; consequently the soil is thereby pulverised. Cohesive soils retain the greatest quantity of moisture, and are most benefited by frost. Does lime neutralize the acids contained in the soil? Water washes them away; all acids are soluble in water, and readily unite with it in a great proportion. From the quantity of carbonic acid gas absorbed by vegetables, we have reason to infer that it is of considerable use in the economy of plants. Perhaps, after lime is saturated with this gas, under certain circumstances, its affinity to vegetables may become stronger than to lime, and the lime give out part of it to forward the growth of vegetables. It would appear that water is deprived of part of its carbonic acid gas, when it flows over grass land, as it loses the agreeable taste communicated to it by that gas.

Pure water may therefore be said not to consti-

tute the food of plants, which was once the opinion of some writers on agriculture; but in this case to prepare it for them: therefore, its fertilising effects, when used in irrigation, must be in proportion to the quantity of crude vegetable and animal matter contained in the soil. If this is granted, then the soils to which irrigation may be applied with the greatest advantage will be easily distinguished. Low peat-bogs, the surface of which is generally covered with coarse herbage, might continue to produce heavy crops of hay annually almost for any length of time, and to improve. Even high peat bogs, the surface of which is only partially covered by a few tufts of heath, might by irrigation be rendered capable of producing valuable grasses. I believe that it is chiefly the acids contained in the peat which prove noxious to plants. The acids, I have observed, are soluble in water, and would soon be carried away. We generally observe valuable grasses produced on the sides of rivulets in peat bogs, when the water is not collected on the surface of the bogs, but only runs through them on its passage. Marshy soils, which are usually composed of clay, peat earth, and decayed vegetables, will be found well adapted for water-meadows: Likewise old grass land of every description. But to apply pure water to land previously exhausted of vegetable and animal substances by tillage and repeated cropping, without having received putrescent manure, and expect to reap heavy crops of hay annually, will certainly be attended with disappointment,

as in this case the land is robbed of those ingredients on which the water operates to increase its fertility.

Having mentioned how pure water would produce fertility in soils, could such a thing be found in nature, I shall next proceed to point out how the water commonly used in irrigation is impregnated with fertilising substances: then mention a few of the methods that might be used for enriching it in situations where that is found to be necessary.

It is known, that the vapours which float in the atmosphere serve the useful purpose of receiving and retaining the heat, communicated to it by the rays of the sun. They also serve another important purpose in vegetation, as they consist of what may be considered the most nutritive and best prepared ingredients of the food of plants. The atmosphere is enriched with this fertilising matter, from the effluvia, and other exhalations, of putrid vegetable and animal substances, on the land, and the shores of the sea; the smoke and vapours from the combustion of vegetable, animal, and mineral substances; the perspiration of animals, &c. These unite with the moisture in the atmosphere in forming the rain and dew, and fall down to meliorate the earth. Rain-water is found to contain about one-thousandth part of those substances. When it falls in gentle showers, by filtering slowly through the soil containing the roots of vegetables, the water deposites part of these substances, to add to the stock of the food of plants contained in the soil. But it will be observed, that

the soil derives this benefit from the rain, only when it falls so slowly as to be imbibed by the earth. For when it falls in torrents, which is frequently the case about the autumnal equinox, and at some other seasons of the year, the water has not time to deposite the enriching substances it contains, but collects in small streamlets on the surface of fields; and besides the fertilising substances it contains when it falls, it carries alongst with it the finest particles of vegetable, animal, and calcareous, matter, as well as earth, in the course of its progress. These it conveys first into rivulets, then into rivers, and ultimately to the ocean, if they are not arrested in their passage, by flowing over meadows, prepared for their reception. In such cases, putrefaction, combustion, the perspiration of animals, lands in pasture, as well as in tillage, roads, towns, and too often the dunghill of the farmer, contribute to enrich the water.

Various means might be employed to enrich water, for the purposes of irrigation. Reservoirs might be made near farm-buildings, to receive the drainings of courts, houses, &c., and a rill of water conveyed into them occasionally to cleanse out the sediment. Weeds, or any succulent plants, thrown into stagnant pools, would tend to putrefy the water. The animalcules bred in such abundance in these vegetable infusions, would also add to its enriching qualities. The water in which flax is steeped should always be used. Earth of all kinds thrown into water on its passage to the meadows, would also be

attended with beneficial consequences. Clay, or clayey loams, might be used for gravelly or sandy soils; and sand, or sandy loams, for soils mostly composed of clay. All the above mentioned soils might be used for the surface of peat-bogs. Thus the soil of meadows might be deepened, and its texture improved.

The water of the richest quality is generally to be found in the vicinity of towns, where the common sewers empty themselves. The drainings of Edinburgh have been for years past used in irrigating the meadows east of the town; and although done in a slovenly manner, it has been attended with great success. The land which only a few years ago was almost a barren waste, is now by that process converted into fertile meadows, and produces astonishing crops of grass, which is commonly cut four or five times in the season, and is much earlier than any other. The occupiers dispose of the grass, chiefly for green food to milch cows; it is found particularly valuable in spring, before green food from the common meadows, or land in cultivation, can be obtained. Those meadows are let from L. 25 to L. 30 Sterling per acre annually *. The water, though it produces such astonishing effects, is not carried on to the meadow in the richest state. The farmers know so well the value of manure, that they have reservoirs prepared, into which they convey the

* I have been told that some acres have been let at near L. 50 *per annum*.

water, where it deposites the grossest part of the fertilizing substances it contains, before it is suffered to flow over the meadows. These reservoirs they empty occasionally of the sediment, and apply it for manure to the lands under tillage.

The water from the common sewers of towns, though saturated with fertilizing substances, and in many situations capable of being carried on land without the aid of machinery, is almost entirely neglected. In the neighbourhood of London, how many hundreds of acres of land could be pointed out, producing but scanty crops, which, at a small expense, might be rendered of more than double their present value, partly by irrigation. Hyde Park, for example, which is resorted to by people of every description, for amusement and exercise, how much more ornamental and pleasant would it appear, as well as valuable, if covered with rich verdure, than in its present barren state!

Water-meadows may be considered an ornamental as well as a profitable improvement. The early vegetation and superior verdure they possess throughout the year, above all other fields, entitle them to a place in pleasure grounds. Interspersed with groups of trees, they have a beautiful appearance. They may be supposed by some persons to render the air unwholesome, as in countries where low marshy grounds are extensive, the inhabitants are often subjected to peculiar diseases. It is probably the putrid effluvia, and carbonic acid gas, evolved during fermentation and putrefaction, which prove hurt-

ful*. Water-meadows, from their general management, cannot have ill effects; for at their formation they should first be completely drained; while they are flooded, the water is always in motion; and the irrigator, to insure success, must be careful to take off the water, whenever fermentation becomes visible.

Having mentioned what I conceive to be the operations of water in producing early vegetation, and increasing fertility, if the conjectures offered are founded on truth, it is obvious that not only grass-lands, but also lands under tillage, might be meliorated by water.

Moor-land, of which there are such vast tracts in Britain, particularly in the northern parts of the island, where lime cannot be obtained, except at an enormous expence, might be much benefited. In those high situations there are rivulets, which, in many cases, might be carried on the land at a trifling expence, and a few gutters made to distribute the water. By this means the heath might gradually be destroyed, and the mountains covered with verdure. It may be observed, that this effect is naturally produced by the water of springs from the sides of mountains, upon all the land it flows over.

Pasture fields might be greatly improved by wa-

* Medical writers regard as most hurtful those miasmata which arise from marshes containing pure enough water, at the time when such marshes are nearly dried up by the heat of the sun: and the gases evolved from pools of dirty water (such as those to the eastward of Edinburgh), are considered as comparatively harmless.—Ed.

ter, particularly those that are overgrown with moss, and other coarse plants, as irrigation is found to destroy those plants. In Britain the heat in summer is generally moderate, and the crops do not often suffer so much from want of rain as they do in warmer climates. Yet pasture fields sometimes sustain great injury from drought. The growth of their herbage is suspended, and, on thin dry soils, the plants are frequently scorched, and deprived of life. The spots thus withered do not recover their former verdure for a considerable time. The grass in those dry seasons, from its scarcity, is doubly valuable, and might be produced in great abundance in many places, by a complete soaking of water. For this purpose, regularly formed meadows are not necessary.

The draining and cultivation of the extensive peat-bogs in Ireland, having engaged the attention of the Legislature, perhaps a more effectual and less expensive mode of management for their improvement could not be suggested than irrigation, where found practicable. By this means the acids contained in the surface of the bogs would be carried away by the water. The putrefaction of the peat would be promoted, and the spongy quality by which it retains much water would be destroyed. The surface, from the decomposition of the peat, would subside, and become a fit soil for the production of corn, green crops, and rich herbage. The limestone gravel, and marl, with which Ireland abounds, would be found suitable manures. The

latter might perhaps require to be used sparingly for corn-crops, as it is apt to loosen peat-earth too much; but it might be applied in larger quantities, and with greater advantage, on the surface of meadows. In some cases a considerable portion of these substances might be carried on the surface of the peat-bogs by water, when the current was sufficiently strong to support the particles on their passage. Where the quantity of water is scanty, a few reservoirs might be made at convenient places, to accelerate the current at those times when limestone-gravel, marl, or earth, was applied. We know from experience, that peat-bogs which have been overflown by water, and afterwards drained, are found answerable soils for the greatest part of the crops generally cultivated, and also the best manure. The great difficulty, however, would consist in the previous draining of those extensive bogs.

As I intend only to make a few remarks on the modes of forming water-meadows, and after-management, to those who wish for information on those subjects, I beg leave to refer to the publications of Tatham, Wright and Boswell; or they may find much useful information in different papers in the Communications to the Board of Agriculture; Transactions of the Highland Society of Scotland; Edinburgh Farmers' Magazine, &c.

Flat flowing meadows are certainly more profitable than catch-work meadows, when the declivity of the land is answerable, and a sufficient quantity of water can be obtained. The additional quantity

of water leaves more of the sediment, and from the manner in which they are formed, a more equal distribution of this sediment takes place on the surface of the meadow. When the surface intended for a meadow is very irregular, the best method is to plough and crop it, till the sward is reduced, then to form it into ridges, with feeding gutters, drains, &c., and lay it down with suitable grass-seeds. Agrostis stolonifera, Poa trivialis, Holcus lanatus, &c., may be mentioned for peat bogs, and wet marshy soils. For dry soils, Poa pratensis, Anthoxanthum odoratum, Cynosurus cristatus, &c. may be added. Besides the above, the grass of rich wet meadows may be cut at different times of the season, and the seed saved for the former soil; in like manner, the grass of rich dry meadows might be cut, and the seed saved for the latter. This would afford a collection of seed, both of early and late plants, to suit the different soils, and ensure a close sward of grass. The plants best adapted to the soil would soon take the lead, and the remainder disappear.

In situations where the declivity of the land is too great to admit of flat flowing meadows, or the quantity of water is insufficient, catch-work meadows are generally made. If the work is properly executed, and the water carried on to them at different places, the improvement will fall but little short of the flat flowing meadows. When the water is carried all on to catch-work meadows on the highest side of the field, and the whole irrigated at the same

time, the greatest part of the fertilizing substances contained in the water is deposited on that part of the surface it first flows over, and the water becomes purer as it descends, which makes the improvement of the meadows unequal.

According to what has been advanced, the effects of water in decomposing decayed vegetables, &c. contained in the soil, will be much more powerful in summer than in winter, as heat promotes fermentation. Therefore, to disunite the component parts of coarse plants in high situations, on moor soils, peat-bogs, &c., it may be found necessary to irrigate in summer, when water can be procured, and to allow the fermentation to proceed considerably farther the first time the water is applied, than afterwards. It need scarcely be observed, that, in order to preserve the heat in the earth as much as possible, when the water is taken off the meadow in winter, it should be done in the warmest weather, and that the watering should be begun early in autumn, and continued late in the spring, when the weather is cold at these seasons. To increase the fertility of meadows, the water should be used when it contains the greatest quantity of fertilizing substances, which is always the case during heavy falls of rain, particularly when the earth gets the first complete washing in autumn; and this water should never be allowed to return to the ocean, if it is possible to prevent it, till it is purified, as, besides the great quantity of fertilizing substances it holds in solution, it hurries along with it a large

portion of the finest particles of earth, and enriching matter, that have been collected on the surface of the earth during summer. Even rain-water, when it falls to the earth, must, at that season, be much more highly impregnated with those substances, from the exhalations during summer, to which the heat proves so favourable. It was formerly said, that rain-water contained a thousandth part of sediment, but river-water in autumn, I presume, often contains a fifteenth part. It may also be remarked, that land naturally sterile, or land that has been exhausted of its fertility, by repeated croppings, without the application of manure, might be improved much sooner, by pasturing the meadows for a few years after the water was first applied, than by taking a crop of hay annually. But this will depend entirely on the quality of the water, as, if the water is rich, this precaution will not be found necessary.

Water-meadows are generally pastured in spring, as the early grass is found valuable for live stock of every description, before the grass on other fields begins to make its appearance. The stock is generally removed from the meadows about the end of April or beginning of May, and they are shut up for the hay crop. But as, in some unfavourable springs, in high situations, there is very little vegetation at that period, it may sometimes be found advantageous, nay, almost indispensably necessary, from the want of green food, to continue the stock on the meadows a week or two longer, which will keep back the growth of the hay; so that the autumnal rains may commence before the hay is re-

moved from the meadows; and therefore, in order to be prepared for using the water in its richest state, it may be advisable to elevate a few sites at equal distances, to place the ricks of hay upon; so that the meadow might be flooded, if necessary, before the hay is removed from it.

An idea may be entertained by some farmers, that land once formed for water-meadows is consigned to remain unalterably in that state, which may deter some from trying the experiment. But this objection will be easily overcome, when they recollect that they have frequently paid more for a dressing of lime than the expence attending the formation of water-meadows; that it has been proved from experience, that the fertilizing effects of water are more powerful, and the improvement more permanent, than the effects produced by lime; and also, that the meadows may be ploughed with advantage at any future period for corn-crops, &c.

To give an idea of the value of the improvement, I shall attempt to make out an estimate of the expence of forming water-meadows, and the value that may be expected, in ordinary cases, for their produce. To make out an estimate of this kind, with a tolerable degree of accuracy, it would be necessary to fix the local situation of the meadow, the nature of the soil, and quality of the water. The price of hay and green herbage also fluctuates in the same situation. However, I shall suppose it an inland part of the country, distant from any large town, and the water such as is commonly found in those situations,—the water of rivers and rivulets,

not possessed of any considerable quantity of fertilizing substances, except after heavy falls of rain.

I will suppose that 200 acres of water-meadow may be formed on an estate, and that the present value of the land is from 10s. to L. 3 Sterling per acre of yearly rent. As part of the 200 acres may be supposed to be peat-moss, not worth 5s. per acre, I will state the average rent of the whole at 30s. per acre:—

To rent of 200 acres, at 30s. per acre, -		L. 300 0 0
Say that 50 acres of the above could be formed into flat flowing meadows, at L. 9 per acre, - -	L. 450 0 0	
The remaining 150 acres into catch-work meadows, at L. 3 per acre, - - - - -	450 0 0	
Enclosing meadows, where found necessary, can be done at considerably less expence when the feeding and receiving drains are taken advantage of, to form part of the fences; say that the whole will cost 20s. per acre, -	200 0 0	
	L. 1100 0 0	
Interest on farm buildings for money expended, is often calculated at 7½ per cent; but, as these are always decaying, whereas water-meadows continue to improve, 5 per cent. may be considered more than sufficient, which, on L. 1100, the sum expended, is		55 0 0
Carried forward,		L. 355 0 0

Brought forward,	L. 355 0 0
Keeping the meadows in repair and watering, 5s. per acre, - - - - -	50 0 0
Cutting, making, and securing the hay crop, 8s. per acre, - - - - -	80 0 0
	L. 485 0 0

The average crop of the 200 acres of meadow, considering the effects of irrigation, might be estimated at 2 tons of hay per acre; but, as I rather wish to keep within, than exceed the truth, I will state it at 1½ ton; in all 300 tons. The difference between the nutritive quality of natural hay and that of straw, has been experienced by the most of farmers. They must have observed the condition of cattle wintered on the former, compared to that of those wintered on the latter food. Natural hay is considered by some graziers better for cattle and sheep than rye-grass and clover. In a year like the present (1820), it would bring nearly L. 5 per ton; but I will state the average value at L. 3, 3s.;

Which, for 300 tons, is - - -	L. 915 0 0
It is well known, that spring is the most difficult season in the year to keep up the condition of live stock, and that if they are then allowed to fall off, from want of nutritive food, or any other mismanagement, they require a large quantity of the summer's grass before they recover their former condition. The spring-grass of water-meadows is rendered doubly	
Carried forward,	L. 915 0 0

Brought forward,	L. 915	0	0
valuable on this account, not only for maintaining, but for improving the condition of cattle at that season, when no other grass can be obtained. The value of the spring pasture may therefore be stated at 15s. per acre, or, - - - - - - -	150	0	0
The after-math, or pasture after the hay is removed from the meadows in autumn, is also valuable for milch cows, or fattening cattle, as the food on pasture fields, at that season, generally becomes scanty. It may therefore be stated at 10s. per acre, - - -	100	0	0
	L. 1165	0	0
Deduct from this sum the rent of land, interest on capital expended in forming the meadows, and expence of management, -	485	0	0
Remains,	L. 680	0	0

The clear profit, agreeably to the above estimate, is L. 3, 8s. per acre annually, which is small when compared with the flattering accounts which have appeared in every publication on that subject. But, it may be observed, from the manner in which water has been shewn to operate, in rendering land fertile, that the profit may be more or less; as the beneficial effects produced by irrigation must depend entirely on the quality of the water used, and the vegetable matter, &c. contained in the soil to which it is applied. The farmer may therefore be enabled to form a pretty just estimate of the improvement, by examining the soil and water to be appropriated to this purpose.

It may be questioned, whether flattering accounts of agricultural improvements have a tendency to advance or to defeat their object. To become eminent or very successful in any undertaking, no doubt requires a small spark of enthusiasm; but the farmer must be a little discouraged, and feel disappointed, when, instead of L. 20 per acre, or some large nameless sum held out to his imagination, he only realizes L. 3 or L. 4, though the latter is more than, in ordinary cases, is obtained from any other improvement in agriculture. Although I mentioned flat flowing water-meadows as most advantageous, where ground is answerable, and the supply of water sufficient, yet, as the expence of forming is so much higher, I am of opinion that catch-work meadows ought to take the lead in the Highlands of Scotland. There is scarcely a rill of water that might not be turned to good account, in this manner, at a trifling expence. I could undertake to irrigate above 5000 acres, at L. 2 per acre, which would more than double the value of the herbage. The method of forming catch-work meadows being so simple, were the practice once introduced, in many cases the farmers might execute the work themselves, in such a manner as to answer all the purposes of irrigation, for little more than L. 1 Sterling per acre. Pasture fields, inferior in quality, and incapable of producing tolerable crops of hay, from the effects of mountain springs, may be greatly improved, and rendered in a few years sufficiently rich to produce that crop.

The advantages of water-meadows being so little known in the greatest part of Scotland, the farmers do not feel the want of this improvement. But in those counties in England where they abound, the farmer looks on a farm, without this appendage, as an Irish peasant would look on a farm where the cultivation of potatoes was prohibited.

From what has been advanced, the great difference, for every species of crop and purpose of husbandry, betwixt soils naturally wet, and those soils occasionally overflown, or watered by art, may be easily accounted for. On soils naturally wet, do we not observe effects produced quite the reverse of the effects produced by irrigation? Vegetation, instead of being forward in spring, is backward; the crops, if ever they do arrive at maturity, are late; the quantity of the produce is deficient, and the quality inferior. With water-meadows it has been shewn that irrigation preserves a higher degree of temperature during winter; and, it must be understood, that, when the water is taken off the meadows in spring, the soil should be completely drained, so as to leave only a sufficient quantity of moisture for the purposes of vegetation; so that the rays of the sun may have free admission to raise the temperature of the soil, and consequently carry forward the growth of the herbage: whereas, in soils naturally wet, the temperature is much lower during winter; and, when the solar rays, from their increased heat, begin to operate in spring, they expend their strength in evaporating the superfluous water from the surface, which is known to produce cold; and, as long as the

soil continues soaked with water, the heat descends very slowly into the earth; as the heat, in this case, is applied to the upper surface of the water, which, by the expansion of its particles, cannot descend by its carrying power; and it was formerly observed that water impairs, in a great degree, the conducting power of the earth *.

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* Much valuable information on the *practice* of irrigation, will be found in the First Volume (p. 142.), and in the Third Volume (p. 224—338), of the Society's Transactions. The latter volume, in particular, contains a full and distinct Survey and Report of the Water-meadows formed on the estates of the Duke of Buccleuch, under the direction of Mr Stevens, a gentleman of great experience in this line.—Edit.

ON

SOWING THE SEEDS

OF

FOREST TREES;

FROM AN ESSAY ON THE SUBJECT

By Mr JOSEPH UDNEY, Moffat; written in 1819.

I. *Enclosing.*—This should be done by one or other of the following Fences. 1st, A double stone-dike, height with its coping 6 feet. 2d, A sunk fence faced up with stone 5 feet high, with a hedge along the top of the bank. 3d, A ditch and hedge; the ditch to be 6 feet wide at the surface, 3½ feet deep, and 1 foot wide at the bottom; the earth from the ditch to be used in making up the bank above the thorns, the line of which is to face the ditch, and a dead hedge to be laid along the top of the bank, to the height of 2½ feet.

II. *The kinds of seed to be sown.*—These are as follows:

	lb.	oz.
1. Common fir-seed - -	1	0
2. Spruce fir-seed - - -	0	8
3. Larch fir-seed - - -	0	8
4. Elm-seed - - - -	0	6
5. Birch-seed - - - -	0	5
6. Ash-seed - - - .	0	8
7. Alder-seed - - - -	0	5
	3	8

The reason for sowing this quantity of 3 lb. 8 oz. to the Scotch acre, is to ensure an abundant crop, after allowing for a considerable proportion which may not grow, or be afterwards destroyed by birds and vermin. If it were not for this, one-third of the quantity might be sufficient. The Mountain-ash or Roan, being very ornamental and extremely hardy, a portion of the seeds of this tree may be occasionally introduced.

III. *Soils upon which these seeds may be expected to answer.*—These are, 1*st*, All light and dry land, whatever may be the nature of the soil or surface. 2*d*, All land incumbent on stones and gravel. 3*d*, Dry heaths, the heath to be burnt the year before the land is sown. 4*th*, All soils that produce whins and broom, the whins and broom to

be dug out. *5th,* All dry knolls, however deep the soil may be, if the surface be tender. *6th,* Land poached by cattle, although damp, but without water standing thereon. *7th,* Mosses, whether deep or shallow, if dry. Some distinction, however, is to be made between the seeds, proper for this description of land, and the others; and it is only four of the kinds before mentioned, which Mr Udney recommends for being sown on mosses, viz. The seeds of common fir, spruce fir, larch, and birch, in the proportions there specified. The seeds of the oak and beech, when these also are to be used, are to be planted by the dibble, and not sown by the hand, as will be afterwards noticed.

IV. *Mode of Sowing.*—All the seeds must be mixed together in a sowing sheet, and the sower must only use the thumb and two fore fingers in taking hold of the seed, which he must scatter very sparingly. If each seed could be placed at half a foot distance from another, that would be sufficient. It will be necessary, in order to direct the sower, to set up two lines of poles, at three yards distance from one another, that being space enough to be covered by one cast of his hand. When one length is gone over in this way, one of the lines of the poles is removed, and set up again at the same distance, on the other side of that which is still left standing, and so on over the whole space to be sown. As some of the seeds are heavier than others, and would fall to the bottom of the heap in the sheet, care must

be taken to stir them from time to time, so as to keep them mixed as equally as possible, and a calm day must be chosen for sowing them, that they may fall regularly.

With regard to the dibbling of the acorns and beech-mast, the planter must be provided with poles as before, and a dibble shod with plate-iron three inches up from the point, with an apron to hold the acorns. He then begins upon the line of the poles, and makes a hole with the dibble, into which he drops two acorns, and the same at every four steps forward upon this line. When he has got to the end of the field in this manner, the poles are again set up at four steps distance, and he goes on to dibble, and drops the seeds upon the new line as before. In this way the seeds are placed at 12 feet distance from one another; but if any other distance be preferred, it is easy to mark it off and deposite the seeds in the same manner. Two seeds are to be put into each hole, for the same reason that the seeds sown by hand are recommended to be in greater quantity than would be necessary to produce a full crop, namely, as a security against a partial failure.

V. *Covering the Seeds.*—This is to be done by means of a thorn harrow, loaded with a piece of wood, and the land is to be twice gone over in the same manner as in harrowing a corn-field. A thorn harrow is thought to be better than any other, as it shakes down all the seeds from the tops of the grass, thus placing them out of the reach of birds. The

harrow on dry land may be drawn by a horse, but on moss where a horse could not so well be employed, it may be dragged by one or two men. In the case of moss, it will be necessary to draw a ditch round the field, and to intersect it with small drains where-ever they are necessary.

VI. *Protection from Vermin.*—The rat, and the water and land mouse, not only destroy the seeds, but they sometines peel off the bark of young trees, which is thought to be the reason of so many firs dying away after a few years growth. These vermin may be destroyed by a trap formed of a square log of wood, with three small holes on one side to admit the land mice, and three larger on the other for the water mice; each hole having a spring with a piece of cheese, or some other bait fixed within it. A careful person should go through the field twice or thrice a week to examine the traps, and by this means, it is thought that the loss occasioned by the depredations of these vermin might be much prevented. Young tree plants, as well as hedges, are also injured by insects, which in some seasons have occasioned great damage in different parts of Scotland; but Mr Udney does not suggest any mode of protection from this enemy; nor against the depredations of hares, which are also very extensive.

The author of the Essay recommends that particular attention should be paid to the goodness of the seeds used, which, in the case of proprietors of wood-lands, ought to be collected by the proprietor's

forester or gardener, who should pare down the cones with a knife to ascertain their soundness. The best time to gather the fir-seeds is from October to January. The beech-mast is commonly ready by the end of May or beginning of June. All the ash keys must be in the rot heap for one year before they are sown; and that heap ought to be turned over at different times to prevent it from heating. The seed separates from the winged pod while in this state, and is then ready to be sown with the other seeds in spring.

The author of this Essay says, that he has stated nothing but what he has learned from thirty years' practice in the planting and sowing of tree-seeds, both upon waste and cultivated lands, and he refers to the estate of Annandale in Dumfriesshire, and Kirouchtree in the Stewartry of Kirkcudbright, where he sowed the seeds of forest trees many years ago, and which have produced trees now equal to, if not better, than those which were then planted in the same quarter. In many situations he would prefer sowing to planting; and he adds, that the wood of all trees which grow from seed is the best, being hard and solid, while the bark is thin and clean, and the tree grows faster and lives longer.

COMPARATIVE EXPERIMENTS

IN THE

SOWING OF WHEAT,

BY DRILLING AND BY BROAD-CAST.

By Mr John Lawson at Oldmills, in the County of Moray.

To the Secretary of the Highland Society.

Sir, *Oldmills*, 12*th November* 1822.

I wrote to you on the 9th of June last, inclosing a report by Mr Brander and Mr Young of the state of wheat on the farm of Linksfield, and now send you the rest of the particulars required by the Highland Society, viz. An account of the nature of the soil, the management of the ground, the expence of preparing and manuring the land, and of sowing, hoeing, and reaping the crop, the quantity of seed sown, and the amount of the produce of drilled wheat; compared with the extent, management, quantity of seed, expence and produce of wheat sown broadcast, on ground of similar quality on the same farm, and adverting also to the comparative weights of the grain produced.

Before entering, however, on this subject, it will be necessary to observe, that there were two fields under wheat on the farm of Linksfield, which, for greater brevity and clearness, I shall denominate No. I. and No. II.

The field No. I. consists of a sand and clay loam, rather light than heavy, and produced a crop of oats in the year 1819. It was fallowed during the year 1820, and received four ploughings besides the seed-furrow. After every ploughing (except the first) it received three double streaks with the harrows, the first one along the ridges, the next across, and the third along again. After the first ploughing it received only two double streaks with the harrows, the first along the ridges, and the next across them. Previous to the last of the four ploughings, lime was spread upon the land at the rate of 25 bolls per acre; and immediately before the seed-furrow was given, dung was spread upon the field at the rate of 25 single cart loads per acre.

The following Table contains the particulars respecting the *drilled wheat*, viz.

No. of Acres.	Time of Sowing.	Time of Cutting.	No. of Threaves.*	When built into Stacks.	When Thrashed.	Quantity of Grain produced.	English weight of Grain per firlot.
A. R. F. 4 1 36	1820. Nov. 8.	1821. Sep. 20.	169½	1821. Sep. 24.	1822. Jan.	B. F. 57 3	ST. LB. 4 2½

* A threave contains 24 sheaves, each sheaf measuring 30 inches round the band.

The following is a state of the expence attending the raising of *drilled wheat*, viz.

	L.	s.	d.
To five ploughings to 4 acres 1 rood 36 falls of ground, at 10s. per acre for each ploughing, including harrowings, - - -	L. 11	3	9
To 111 bolls 3 firlots of lime-shells for do., at 4s. per boll, counting 4 firlots to the boll,	22	7	0
To slaking and spreading lime on do., at 6s. 8d. per acre,* - -	1	9	10
To 111 loads of dung for do., at 1s. 6d. per load,	8	6	6
To carrying dung from the dung-yard to the field, making it into a dunghill, turning dunghill and laying and spreading dung on the field, at 17s. 6d. per acre,	3	18	$3\frac{3}{4}$
To laying off furrows at the distance of 9 feet from each other, for the purpose of guiding the sowing machine, at 1s. 6d. per acre †,	0	6	$8\frac{1}{4}$
To sowing 4 acres 1 rood 36 falls of ground with the sowing machine, at 2s. 6d. per acre,	0	11	$2\frac{1}{4}$
To harrowing do. with three double streaks of the harrows before and after sowing the seed, at 2s. per acre. - -	0	8	$11\frac{1}{4}$
To hoeing do. with the machine, at. 2s. 6d. per acre, - - - - - - -	0	11	$2\frac{1}{4}$
To 3 bolls 1 peck of seed-wheat, at 35s. per boll,	5	7	$2\frac{1}{4}$
To reaping do. at 12s. per acre, - -	2	13	$8\frac{1}{4}$
To carrying home and stacking grain, at 7s. $4\frac{1}{2}$d. per acre, - - - -	1	12	$11\frac{3}{4}$
	L. 58	17	$3\frac{1}{2}$

* To the *spreading* of the lime might be added also the carriage of it: but this must vary according to the distance of the field from the lime-kiln.

† This operation is performed by a plough with a pair of horses.

The following table contains the particulars respecting wheat *sown broad-cast*, viz.

No. of Acres.	Time of Sowing.	Time of Cutting.	No. of Threaves.	When built into Stacks.	When Thrashed.	Quantity of Grain produced.	English weight of Grain per firlot.
A. R. F. 1 2 36	1820. Nov. 6.	1821. Sep. 20.	65	1821. Sep. 24.	1821. Dec.	B. F. 21 1	ST. LB. 4 3

The following is a state of the expence attending the raising of wheat *sown broad-cast*.

To 5 ploughings to 1 acre 2 roods 36 falls of ground, at 10s. per acre for each ploughing, including harrowings, - - - -	L. 4	6	3
To 43 bolls of lime-shells for do. at 4s. per boll,	8	12	0
To slaking and spreading lime on do. at 6s. 8d. per acre, - - - -	0	11	6
To 43 single cart-loads of dung for do. at 1s. 6d. per load, - - - -	3	4	6
To carrying dung from dung-yard to the field, making it into a dunghill, turning dunghill, and laying and spreading dung on the field, at 17s. 6d. per acre, - -	1	10	$2\frac{1}{4}$
To sowing do. at 6d. per acre, - -	0	0	10
To harrowing do. with three double streaks of the harrows, at 4s. per acre, -	0	6	$10\frac{3}{4}$
To reaping corn on do. at 12s. per acre,	1	0	$8\frac{1}{4}$
To carrying home and stacking grain, at 7s. $4\frac{1}{2}$d. per acre, - - -	0	12	$4\frac{1}{2}$
To 2 bolls of seed-wheat, at 35s. per boll,	3	10	0
	L. 23	15	$2\frac{3}{4}$

The field No. II. consists of a good light loam, with a considerable mixture of sand. Part of this field (during the year 1820) produced a crop of *potatoes*, and part a crop of *turnips*. The *potatoes* were taken out of the ground in the month of October, after which, the field was harrowed with a double streak of the harrows across the drills, and afterwards ploughed in the direction of the harrowing. The *turnips* were taken out of the ground in the month of January, after which, the field, as in the former case, was harrowed with a double streak of the harrows across the drills, and afterwards ploughed in the direction of the harrowing. White Essex wheat was sown after the potatoes, and Talavera wheat after the turnips.

The following table contains the particulars respecting the *Drilled Wheat*, viz.

	No. of Acres.	Time of Sowing.	Time of Cutting.	No. of Threaves.	When Thrashed.	Quantity of Grain produced.	English weight of Grain per firlot.
	A. R. F.	1820.	1821.		1822	B. F. L.	ST. LB. OZ.
Essex Wheat.	4 3 22	Nov. 20.	Sept. 12.	111½	Feb.	10 3 1	1 3 0
		1821.			1821		
Talavera Do.	2 0 14	Feb. 6.	Do.	50½	Dec.	17 0 1	4 3 13

The following is a state of the expence respecting the raising of Drilled Wheat, viz.

To one double streak with harrows, to 6 acres 3 roods 36 falls of ground, at 1s. 4d. per acre,	L. 0 9 3½
To one ploughing to do., at 8s. per acre, -	2 15 9½
Carried forward,	L. 3 5 1

	L.	s.	d.
Brought forward,	L. 3	5	1
To laying off furrows at the distance of 9 feet from each other, for the purpose of guiding the sowing machine, at 1s. 6d. per acre,	0	10	5½
To sowing do. with the sowing machine, at 2s. 6d. per acre, - - - -	0	17	5¼
To three single streaks with harrows to do. before and after sowing, at 2s. per acre, -	0	13	11¼
To hoeing do. with the machine, at 2s. 6d. per acre, - - - - - - -	0	17	5¼
To reaping do., at 12s. per acre, - -	4	3	8¼
To carrying home and stacking grain, at 7s. 4½d. per acre, - - -	2	11	5
To 3 bolls 3 firlots 2 lippies of common Essex wheat, (except 1 choppin), at 35s. per boll, - - - -	6	15	8
To 1 boll 3 firlots 3 lippies of Talavera wheat, at 35s. per boll, - -	3	7	11¼
	L. 23	3	0¾

Note.—The potatoes and turnips were dunged in the same way, and the expence of both may be considered as proportionally equal to the expence of dunging the field No. I. This expence, however, it is not necessary to state here, as it is counterbalanced by the value of the turnips and potatoes.

The following table contains the particulars respecting the Wheat *sown Broadcast*, viz.

No. of Acres.	Time of Sowing.	Time of Cutting.	No. of Threaves.	When Thrashed.	Quantity of Grain produced.	English weight of Grain per firlot.
A. R. F. 1 2 9	1820. Nov. 20.	1821. Sep. 12.	36½	1822. March.	B. F. L. 12 2 0	ST. LB. 4 3

The following is a state of the expence respecting the raising of Wheat sown Broadcast, viz.

To one double streak with harrows, to 1 acre 2 roods 9 falls of ground, at 1s. 4d. per acre, -	L. 0	2	$0\frac{3}{4}$
To one ploughing to do., at 8s. per acre, -	0	12	$5\frac{1}{4}$
To sowing do., at 6d. per acre, -	0	0	$9\frac{1}{4}$
To three single streaks of harrows after sowing, at 2s. per acre, - -	0	3	$1\frac{1}{4}$
To reaping do., at 12s. per acre, -	0	18	8
To carrying home and stacking grain, at 7s. $4\frac{1}{2}$d. per acre, - - -	0	11	5
To 1 boll 2 firlots $\frac{1}{2}$ lippie of seed-wheat, at 35s. per boll, - - -	2	13	7
	L. 5	2	$0\frac{1}{2}$

I have now given you an account of all the particulars respecting the raising of wheat on the farm of Linksfield. With the management of the land, and the quantity of seed, expence and produce of wheat sown broadcast, I have contrasted the management of land, quantity of seed, expence and produce of wheat sown in drills, adverting at same time to the comparative weights of the grain produced. I have, however, refrained from making any observations of my own on the result of these experiments, leaving it to the Society to draw such conclusions from them as the experiments themselves may naturally suggest. And I am, Sir, &c.

JOHN LAWSON.

P. S. I have found from former experiments on *drilling*, that, in very rich lands, the drilling increases the strength of the straw, and allows the air to pass through the rows, by which the lodging of the grain is prevented. In particular, I had a field of drilled barley on my farm of Old Mills this year, from which I reaped ten bolls per acre, whereas I am convinced, that had it been sown broadcast, I would not have reaped nearly so much, nor would the quality of the grain have been so good as it was. I saved, besides, my *grass-seeds*, which would otherwise have been destroyed by the lodging of the grain *.

J. L.

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* The comparative results of these experiments may be exhibited in the following abstract.

Mode of Sowing.	Extent.			Expence.			Produce.			Produce per Acre.	Expence per Boll.		
	A.	R.	F.	L.	S.	D.	B.	F.	P.	Bolls.	L.	S.	D.
1st, Drilled,	4	1	36	47	12	1¼	57	3	0				
	6	3	36	23	3	0¾	57	3	2				
	11	1	32	70	15	2	115	2	2	10.09	0	12	2¾
2d, Broadcast,	1	2	36	23	15	2¾	21	1	0				
	1	2	9	5	2	0½	12	2	0				
	3	1	5	28	17	3¼	33	3	0	10.28	0	17	1¼

In the weight per boll, the difference, though very small, is rather in favour of the drill. But, in other respects, there is hardly any difference worth notice.—ED.

REPORT AND CERTIFICATE

OF

FIORIN GRASS,

CULTIVATED IN ARGYLESHIRE;

By Mr Donald Maccoll, at Lettershuna, Appin.

Appin, 26th October 1821.

At the request of Mr Donald Maccoll, we have day this inspected a field of Fiorin Grass at Lettershuna, Appin, consisting of about 3 English, and consequently considerably more than 2 Scotch, acres; and on having part of the grass cut and weighed in our presence, find the produce to be 2325 stones per Scotch acre. The field in question, until it was lately prepared for fiorin grass, was not worth 10s. per acre annually, from its wetness, and from its having been principally covered by brush-wood, rushes, sedges, &c. and we now consider it well worth 10 guineas per acre, from the immense quantity of winter-food upon it, where winter-food for cattle is so valuable. Mr Maccoll's first operation upon the field was to root out the bushes, then to drain the land as well as possible from its local situation, but we consider

it still too wet for general cultivation. He then got it delved with spades, making the surface nearly as smooth as an onion bed. Fiorin grass plants were obtained all the way from Mr Baird at Shotts (to make sure of the proper quality), that gentleman having formerly obtained a premium from the Highland Society for the same article. The strings of grass were laid with great care at distances of three or four inches from each other, and afterwards men were employed with barrows to carry on a top-dressing of fat earth and lime to cover the plants, but there was not a sufficient quantity of this compost laid on to conceal them entirely. Barrows were preferred to horses and carts, because the horses' feet and cart-wheels would have deranged the plants; besides the wetness of the season made part of the field too soft for horses and carts, although they can now be used in carting off the grass without the least injury. Half the field consists of clay and loam; the other half is mossy, though perhaps it may be termed peat-earth; and the fiorin seems as near as possible equally luxuriant over the whole. Many have come from a distance to inspect the field, and some who have seen it, have expressed a determination to prepare land for fiorin grass immediately. Unless some others in Argyleshire have brought their experiments to greater perfection, it is our decided opinion that Mr Maccoll is entitled to the highest premium from the Highland Society. It may be observed, that such operations as the above are too expensive

for many men's means; but let it be remembered, that the field is now permanently laid down, and that a top-dressing of ashes, dung, or a little earth mixed with lime, every third year, will give a produce of the value of at least 10 guineas per acre, annually.

JOHN STEWART,
Minister of Lismore and Appin.

R. DOWNIE,
Member of the Highland Society, and
J. P. for Argyleshire.

Notice respecting CALVES, which were reared chiefly on

FIORIN TEA;

In a Communication from Sir James Stewart Denham of Coltness, Baronet.

Coltness, 28th December 1822.

In Spring 1820, I ordered the calves, being the produce of Highland cows, calved in the straw-yard, and two or three days old, to be taken from their mothers, and fed on fiorin-tea. We took two pounds of fiorin hay, and put them into 10 Scotch pints of water, which were boiled down to half that quantity; to this, I ordered to be added, one Scotch pint of skimmed milk, and the calves to be fed thereon exclusively.

I calculate the value of the fiorin to be a halfpenny a pound, and the skimmed milk a penny a Scotch pint. There are now 8 calves in the straw-yard so reared, highly approved of for their shapes and condition, and I have every reason to believe that they were fed according to my directions.

There are also now to be seen at Coltness 5 calves the produce of the milch cows of the Ayrshire breed,

which were fed on fiorin-tea made as before, to which was added one penny worth of treacle: no breeding calves can be in better condition than they are at present. I left Coltness for England on the 19th of May, at which time the above calves had received no milk; and, in presence of Lady Stewart, and Miss G. Dalrymple, they decidedly preferred the fiorin-tea so made, to sweet milk. If the above calves received any milk after my departure for England, it was contrary to my orders; and in testimony of the above, I appeal to my factor Mr David Leighton, and to the affidavit of my shepherd Thomas Macqueen. JAMES STEWART D.

I hereby certify, That the directions given by Sir James Stewart for feeding of calves, as contained in the prefixed statements, were strictly attended to, as far as is known to me; with the exception, that the Highland calves in spring 1820, got one pound of oatmeal, in addition to the allowance of skimmed milk and fiorin-tea therein mentioned.

DAVID LEIGHTON.

At Coltness, the 27th of December 1822. In presence of General Durham of Largo, one of his Majesty's Justices of the Peace for the County of Lanark,

Compeared Thomas Macqueen, shepherd at Coltness, who being solemnly sworn, depones, That the eight cattle of the West Highland breed now in the

straw-yard at Coltness, when calves in spring 1820, were in general taken from their mothers when new calved, and some when two or three days old; that they were fed about five weeks on one Scotch pint of skimmed-milk, five pints of fiorin tea, and one pound of oatmeal per day, and afterwards turned to the grass. All which is truth as the deponent shall answer to God.

THOMAS MACQUEEN, *Shepherd.*

Sworn before me at Coltness the 28th day of December 1822,

JAMES DURHAM, *J. P.*

Carstairs, 1*st January* 1823.

I Elizabeth Hastie, am willing to attest upon oath before any Magistrate, that, in spring 1822, five calves of the Ayrshire breed were reared by me at Coltness, on six Scotch pints of fiorin-tea, in addition to which was given mixed along with the tea one pound of oatmeal, one quart of skimmed milk, and one pennyworth of treacle.

That the calves were thus fed for eight weeks, and were then turned to grass: That the said calves are the same now in the straw-yard at Coltness, where they may be seen.

BETTY HASTIE.

COMMUNICATIONS

FROM

Mr William Pope at Gartymore, near Helmsdale, County of Sutherland.

1. *On the Farina of Potatoes; and the means of preserving them.*

31st July 1822.

The Farina of the Potato, commonly called Potato-starch, is readily obtained by previously washing the potato and grating it fine, and then washing the grated substance in pure water. The farina will precipitate very rapidly, and the skins and other impurities will remain suspended in the water. This water is to be carefully decanted off, and three or more washings in the same manner will be found sufficient to purify the farina effectually. It is then to be dried upon clean canvas sheets or hair-cloth, in the sun and air, with attention; and when perfectly dry it will keep for any length of time. This farina, put up in tin canisters, it is humbly conceived, would prove a most valuable article in long voyages, particularly as it would furnish a very desirable nutritive article, perhaps

not inferior to arrow-root powder, prepared as sago is dressed, with a little sugar and a glass of white wine. Let a small portion of this farina (say two ounces), be put upon a plate in a well aired room, and upon another plate put two ounces of fine wheaten flour, and, at the distance of forty-eight hours, let both articles be carefully weighed again. The potato-farina will be found of nearly the same weight as when it was laid down, but the wheaten flour will be found considerably heavier, particularly if the weather is moist. From this experiment, it is very evident that the wheaten flour absorbs moisture from the air of the atmosphere, more readily than the potato-farina. By this simple discovery, it is humbly conceived that the potato farina possesses extraordinary antiputrescent properties. For distant voyages, in particular, this valuable root may be prepared in another manner, to furnish desirable articles of food for the healthy as well as for convalescents.

Let the potato be fully boiled, skinned, and then bruised to small pieces, and dried upon hair-cloth on common malt-kilns, till it gets quite dry and hard; it will keep sweet a very long time put up in good flour barrels. This preparation of the potato, after being pounded in an iron-mortar, will make an excellent mess of soup, and will likewise make a very palatable plumb-pudding, or a plain pudding, with the addition of a little lemon or lime juice, or even good vinegar, and a little sugar.

Lastly, in December or January, in soft weather,

before the potato begins to sprout, let them be put in a large tub, and cover them with boiling water. As soon as the water begins to cool, let it be poured off, and the potatoes spread upon a boarded floor, until they are dry. Then put them up in casks, mixed with some fine sand, and they will keep perfectly sweet during spring and summer, without losing their substance by vegetating. The sand will contribute to save them from being injured by frost.

W. P.

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2. *Preparation recommended for the Destruction of Vermin, and the Pickling of Seed-Wheat.*

26th July 1822.

Hitherto it would appear that no effectual remedy has been discovered to check the destructive ravages of the grub and caterpillar vermin, which in orchards and kitchen gardens occasion so much loss to the industrious gardener.

The following preparation is humbly recommended as a valuable remedy to vanquish, if not entirely to exterminate, all the tribe of vermin that prove so injurious to the industry of those who cultivate the soil.

Take tobacco leaves, cut them small, and make a strong infusion of them in hot water poured up-

on them in a large tub. The infusion must not be boiled, as that would carry off in steam a great part of the most valuable principle, the essential oil of the tobacco. When this infusion is cold, dissolve in it one or two pounds of common gum-arabic; when the gum-arabic is dissolved, a pound or more of flour of sulphur may be added, particularly if the infusion is intended to give a smart washing to wall fruit-trees.

It is humbly conceived that the month of January, if the weather is soft, is the best season for the application of this infusion to wall fruit-trees, and to all kinds of gooseberry and currant bushes, previously pruning all bushes, and weeding clean round the stems. Some days after the first washing with a watering-pot, or garden-engine, it would be beneficial to prepare a portion of the infusion with an additional quantity of the gum-arabic, to be applied with a brush to the stems of the bushes, at least for a foot or more above the ground. The air of the atmosphere will generally keep the gum moist; and any vermin that may rise from the earth, in the course of the spring, will be arrested by the gum, and the tobacco will kill them effectually. There is one species of grub that never quits the ground till he becomes a kind of butterfly. This species destroys cabbages and cauliflowers, by attacking the roots about an inch under the surface of the earth. It would therefore be proper, before these vegetables are hoed up, to give a small portion of the infusion to each plant from a

tin tea-kettle. And it is further recommended, when these plants are taken up to be transplanted, that their roots should be put in the infusion for a few minutes before they are dibbled into the earth. It is wonderful how much this infusion promotes the vigour of vegetation, where it gets to the roots of any plant.

Vipers, which are common in gardens in England, and the south of Scotland, will soon forsake gardens in which the said infusion is used freely; and the essential oil of tobacco, if applied to the mouth of a viper, upon the tip of a small rod, till it bites at the rod, will kill the reptile to a certainty. This oil will kill the most poisonous snakes of warm climates.

The tobacco-leaf yields a considerable quantity of essential oil, which is readily obtained by smoking tobacco in a tube nipple-glass. The oil will condense in the bulb of the nipple-glass; and it is so extremely caustic, that it will destroy the epidermis where it touches the human skin.

It is peculiarly gratifying to observe, that the said infusion with gum-arabic* and flour of sulphur will be found a most important article to the farmer in the pickling of wheat or barley seed; and it is not necessary that the grain should be in the liquor above half an hour. The grain should be put in the infusion in large tubs; and, when taken up, put in bags, and

* The principal use of the gum-arabic is to carry the flour of sulphur into the soil attached to the seed.

Lochcoat Loch is situated in a deep valley, nearly at the eastern extremity of the parish of Torphichen, in the county of Linlithgow. The extent of it, and of the adjoining marsh, was about 22 Scotch acres.

It is surrounded on every side by high grounds; nearly the whole was covered by water, and chiefly overgrown by the Equisetum palustre or large bog pipe. It was amply stocked with pike, but, except the amusement afforded to the angler, and its beauty, the lake seemed a useless appendage to a property of a few hundred acres.

On the other hand, as, upon different soundings, the greatest depth of water was found to be five feet, and below it twelve feet of the richest alluvial mud, the value of such an acquisition, supposing that the draining could be accomplished, seemed very great.

The only obstacle seemed to be the want of a sufficient outlet and fall for the drains, for though there was a subterraneous passage, through which the water from the lake had for ages found an issue, at first glance it did not appear likely to answer the object in view.

An experienced leveller was therefore applied to; the levels were taken by him, and he reported that L. 400 might be necessary for opening an outlet at the west end, besides the expence of the necessary drains; and, he added, that no reliance could be placed on the natural outlet.

It subsequently appeared that he had under-calculated the extent that the mud might subside

upon the water being let off, which occasioned a considerable addition to the expence.

Notwithstanding this report, I was induced to persist in my intention of attempting the undertaking, placing much reliance upon the practical skill and knowledge of the mineral kingdom possessed by the person who proposed to contract for the operation.

The water appeared to permeate a porous stratum of basaltic rock, lying under the limestone, which is found in the adjoining high ground, and it occurred to me, that if this natural outlet were enlarged and deepened, there could be little danger of the success of the operation.

During winter 1819, and the early part of spring 1820, by the indefatigable exertions of the contractor, the outlet was opened up, and the drains so far advanced, as that the water was let off in April 1820. The surface then exhibited a sheet of black unctuous mud. Three acres, where there was some solidity, were digged and sown with oats; other 3 acres were ploughed and planted with potatoes, and sown with carrots and rape, and the remaining 12 acres were, in the month of August, pointed over with the spade, laid off in 12 feet ridges, and strewed very thick with rye-grass seeds, with a small mixture of broad clover and rape.

In February 1821, as had been anticipated, it became necessary to widen and deepen the outlet, and to open a tunnel for a few yards into the side of the hill.

After this, the other ditches which hitherto, from the softness of the ground, and their tendency to slide in, had not been carried to the requisite depth, were completed before the month of July, and the whole is now exhibited in the drawing, which will be easily understood from the explanation subjoined to it *. A sluice was constructed, so that, at any future period, the ground may be irrigated, and a close grate was added, through which the water passes, without the risk of the covered outlet being choked up by the leaves or mud.

In 1821, the dry ground, to the extent of 3 acres, was sown with oats and grass seeds ; 2 acres where the equisetum (pipes) had been always most abundant, were planted with cabbages, and in the end of the season were sown with grass seeds.

Though the crops of oats and cabbages were excellent, by far the most abundant crop was from the ground sown (in August 1820) with grass seeds.

From the 30th of April till the middle of November, there was a constant succession of grass; even six cuttings were got, and it seemed nearly impossible to keep it down, by the daily supplies of grass given in the house, to 8 cows 2 horses and 3 ponies, during the period just mentioned; and 2000 stones of excellent hay were stacked up.

The whole ground drained was now in grass, and to save the expence of cultivation, and that the ground may become perfectly consolidated, I have kept it under the same management during the

* See Plate V.

present season, (1822.) The grass was ready for cutting by the middle of May, and though abundant corn crops may be relied upon, it appears, that at the present low prices of grain, it will be more advisable to trust to the returns from the grass.

Besides constantly soiling 5 cows, 2 horses and 3 ponies with cut grass, 2 full crops of well ripened rye-grass hay have been made and stored, the first by estimation 200 stones per acre, and the second upwards of 100 stones per acre. The sward is close and well rooted, and is now kept down by sheep, which were put upon it after the last crop of hay was removed, before the end of October.

The expence of the whole operation has apparently been moderate. The drains, of which the covered ones are 5 feet deep, and the open ones of different depths, as stated on the plan, and the digging and building of the tunnel and sluice,

cost - - -	L. 250	0	0
And the digging of the 22 acres of ground included in the lake and marsh for both crops, and for ridging, opening and clearing of the furrows, - -	132	0	0
Total	L. 382	0	0

It may be proper, in concluding, to add, that the tunnel and drains have been found to be thoroughly serviceable; the water, even in the most severe floods, has always made its escape freely, and, as the improvement appears a beneficial one, so, from

present appearances, it may be reasonably hoped to be permanent.

MUIRAVONSIDE HOUSE,
7th November 1822.

We, two of the Members of the Highland Society of Scotland, hereby certify, That we were well acquainted with Lochcoat Loch, before it was drained by Mr Wishart; that we visited, last summer, the ground drained, when it was bearing a crop of rye-grass hay, and that, in our opinion, it is now in such a state as to produce useful herbage for the pasturage of cattle and sheep.

ALEX. MARJORIBANKS.
ALEX. MACLEOD.

At Edinburgh, the 9th day of November 1822 *years.*—In presence of John Mowbray, Esq. one of his Majesty's Justices of the Peace for the county of Edinburgh,

Compeared Patrick Wishart, writer to the Signet, who deponed and made oath, That the operations stated in the preceding report were truly performed by him, and at his expence, at the times therein specified; and that the extent of the drains mentioned in the sketch or drawing by Alexander Thornton, hereto annexed, is, as therein stated, to the best of his knowledge and belief, 566 roods Scotch measure. All which is truth, as the deponent shall answer to God.

PAT. WISHART.

Sworn before me,

J. MOWBRAY, *J. P.*

ON THE DRAINING OF MOSS OR BOG LANDS.

THE Society having offered, in 1821, premiums for the drainage of moss or bog lands, with a view to the amelioration of the climate, as well as to the improvement of the soil, the first premium (being a piece of plate, Twenty Guineas value) for an extent of not less than 500 roods; and the second (a piece of plate of Ten Guineas value) for an extent of not less than 300 roods; and which premiums were continued in 1822;—several communications were duly lodged with the Secretary, in claim of these premiums. The substance of these, which it is thought unnecessary to publish at full length, may be shortly stated as follows.

1. *By* MR COSMO FALCONER *of Hartwoodhill, in the parish of Shotts.*

The extent drained was about 15 or 16 acres of deep moss, and the length of the drains 2800 roods

of six yards. In its natural state, the moss was of an irregular surface, covered with heath and stagnant water, and of little or no value. The drains had the effect of rendering it fit for the application of manure, and for being planted, or for producing grain or grasses. It was delved with the spade, laid off into regular broad ridges, covered with ashes, and sown with oats, timothy-grass and rye-grass, in 1822. On account of the excessive drought of that summer, the oats were but a poor crop, but the grasses promised to establish themselves, and to cover the land with useful herbage.—The first premium was voted to Mr Falconer.

2. *By* Mr Andrew Robertson, *Tenant in Myrehead, parish of Muiravonside, county of Stirling.*

The extent drained was 27 acres 2 roods 8 falls, and the length of the drains 1704 roods. The moss, which was in different situations, was not all of the same description; but every part of it was in an unproductive state, owing to stagnant water and superabundant moisture. One of the certificates bears, that, when there was any frost in summer, the bogs were always covered with a dark mist in the morning, which was thought to be injurious to the crops in the neighbourhood. By means of Mr Robertson's operations in draining and cultivating these bogs, the whole were effectually cleared of water, and, in as far as circumstances would admit, rendered fit

for raising grain, or producing useful herbage. The drains were partly open and partly covered; the former done at an expence of 1s. per rood, and the latter at 2s. 10d. per rood; the whole amounting to L. 169 : 14 : 4; but a great part of this expence would have been saved, if the plots drained had been contiguous. The open drains were made 2 feet wide at the surface for every foot in depth; so that for a drain 4 feet deep, the ground was broken at top 8 feet wide. The close drains were between 3 and 4 feet wide at the surface, and from $3\frac{1}{2}$ to 7 feet deep. Such drains, Mr Robertson thinks, should seldom or never be less than 4 feet deep; "because they subside so much, that they would require 2 feet of earth, at least, above the stones." When the bottom of the covered drains was soft, or consisted of a running sand, thorns or brushwood were first laid in, to keep the stones from sinking, and then the rest of the drain was filled with stones in the usual manner. In some places, where the bottom was soft, and the drains deep, nothing but thorns and small branches of trees were used in filling them. These were first covered with turf, and then sand or earth was laid above the turf, to keep the branches close together, the moss itself being thought too light for that purpose. In 1822, the land so drained was partly in turnips, but chiefly in oats. The turnips, which were after a crop of oats taken the year before, and well dunged, produced a middling crop. The oats were unequal, in some places very good, in others so inferior as to produce little more

than the seed; but the whole averaged about 4 bolls per acre.—The second premium was adjudged to Mr Robertson.

3. *By* Mr ALEXANDER CALDER, *Tenant in Starlaw, parish of Bathgate, county of Linlithgow.*

The length of the drains, in this case, was 895 roods, and the expence about L. 60 Sterling. The extent of the moss, on which the drains were made, is not stated; but it is certified, that a very great improvement was effected by means of them; and that the land had been brought into a state fit for bearing corn, and useful herbage.—The Society awarded a third premium, of Five Guineas, to Mr Calder.

ON IMPROVING THE QUALITY OF KELP.

Premiums having been offered by the Society for the finest quality of kelp made on the coasts of the counties of Inverness and Ross, in 1821 and 1822, communications and specimens of kelp were transmitted by the four claimants to be immediately mentioned. These specimens were analysed by Dr Fyffe, the author of a very valuable article on this subject, in the last volume of the Transactions.

With regard to the mode of manufacturing kelp, some useful information has been already laid before the public, in the first and subsequent volumes of the Transactions, which renders it unnecessary to describe, at length, the various processes adopted by different individuals, which differ rather in the degree of care and attention bestowed, than in the general management; but the communication of Mrs Anne Campbell of Strond in Harris, to whom the first premium was awarded, seems likely to be so useful in other respects, as well as on this point, that

it has been thought expedient to insert it, without alteration or abridgment.

Account of the Manufacture of Kelp on the farm of Strond in Harris, possessed in tack by Mrs ANNE CAMPBELL; *transmitted, with Specimens of Kelp made in* 1821, *by* ALEXANDER MACLEOD, *her Factor.*

1*st*, The quantity of kelp manufactured on the farm of Strond, this season, was 115 tons.

2*d*, All the kelp was made from cut-ware of two years growth.

3*d*, The plants used were Fucus nodosus, or lady-ware; Fucus vesiculosus, or bell-ware; and Fucus serratus, or black-ware.

It may not be superfluous to remark, that all the kelp made of cut-ware is from these different plants, and that they are always mixed together, as the different varieties grow on kelp-shores generally, and in the following order: The Fucus nodosus grows on that part of the shore between high-water spring-tides, and high-water neap-tides; and mucous bell-ware, named *grœpach* by the manufacturers, is interspersed with it. As these kinds of ware are but seldom covered by the sea, they are short, and only a little of them can be obtained. The Fucus vesiculosus, or bell-ware, grows on that part of the shore between high-water neap-tides, and low-water neap-tides. From the circumstance of this ware being alternately covered by the sea, and exposed to the air for nearly the same space of time, it grows stronger than

any of the other varieties; is consequently more plentiful, and most productive. That part of it which grows near low-water-mark neap-tides, is of a thinner texture, and is called Floating-ware, or *Gleurach*. The Fucus serratus, or black ware, grows between low-water neap-tides and low-water spring-tides; this variety of ware is plentiful on such shores as are flat, and which only ebb with spring-tides. Black ware makes good kelp, but is not productive, from its thin texture.

Different varieties of tangle-ware appear lower down than the black ware at low-water spring-tides, but are not cut for kelp-making in those parts, and are only used, when drifted ashore, for making *cast-ware kelp*.

4th, The specimens of Strond kelp, now sent to the Society, were taken, without any pains of selection, from about 60 tons of the kelp; each specimen sent being taken from different kelp-kilns, containing from 2 to 2½ tons of kelp each. All the kelp made on the farm, was equal, in quality, to the specimens sent, with the exception of about 6 tons, which were made in a bay, into which there is a run of fresh-water, and where the ware is only covered with salt-water with spring-tides. Kelp made of such ware contains less of the alkaline-salts than when it is made from that which grows in strong tide-ways.

5th, The kelp from which the specimens were taken was sold by Messrs Macdonald and Ravenscroft, agents, Liverpool, for L. 10, 5s. per ton.

6th, The process of manufacturing this kelp is as follows, and though similar, may be found to differ, in some respects, from the general mode of kelp-making. Wherein I consider this difference lies I will point out, by underscoring (printing in Italics) that part of the description of the process.

1st, The ware is cut off the rocks with a common hook, similar to that used for shearing (reaping,) but stronger, and having a rougher edge.

2d, Care is taken to land the ware on clean spreading ground; and if any sand or mud is found to stick to the ware, *it is always washed* before landing it.

3d, The ware is spread out every dry day, and made into small cocks at night. When, in this way, it is found to be pretty dry, *it is made into larger cocks,* and left to heat in them for *six* or *eight* days; but if the ware is of that description which I have mentioned above, as growing in bays, into which there is a run of water, *such ware is always left in large cocks from fifteen to twenty days.*

4th, The ware being thus secured, a dry day, with a good breeze of wind, is watched for, in order to burn it.

5th, The kelp-kilns are constructed of middle sized stones, of hard texture, and built up carelessly; the outsides of the kilns are covered with turf: the length of each kiln is from 15 to 18 feet; breadth $2\frac{1}{2}$ feet, height 2 feet. They are made on the sur-

face of the ground, and on the firmest sward they can find.

6th, The process of burning is as follows: A small bundle of straw or heather is set on fire; the dryest part of the ware is placed over this, and gradually added, until the flames become general through the kiln; then the ware to be burnt is thrown in, little by little, till the whole is reduced to ashes. If, however, it happens, that the day is too calm, or that the ware is not sufficiently dry, so that the ashes cool, and cake into white crusts, *the manufacturer stops burning any more, until he rakes all the ashes in the kiln;* then commences burning again, and goes on in this way until he has the whole thoroughly burnt. Want of attention to this method leaves kelp of a white colour, and porous texture.

7th, The last process is the raking or working of the ashes with an iron with a wooden handle, made for the purpose, until the whole is brought into a solid semivitrified state. Most manufacturers commence this process immediately after the last part of the ware is put on the kiln, and when a good deal of the ware is not sufficiently burnt, and of a black colour. The Strond manufacturers, however, do not *commence raking* the *ashes* for at least half an hour after the last of the ware is put on; so that the whole may be thoroughly burnt. Want of attention to this particular leaves kelp of an ugly black colour.

The raking of the ashes is simply done, by working the kelp-irons through it, until the whole becomes a semi-vitrified mass: *three* or *four* men are employed at this process. If fewer, the ashes will not be sufficiently worked, and consequently a great part of them must be mixed in the next burning.

Finally, The kelp is broken into pieces of about 2 cwt.: these are made into conical heaps, covered with dry ware, and over that is placed a layer of turf, which secures the kelp tolerably well, if early shipped.

The next communication is from Mr ARCHIBALD MACDONALD, tacksman of Rhue, in Arisaig, county of Inverness. The specimen of kelp sent with this was made in 1822, and sold in Liverpool at Nine Guineas per ton. It was, like the former, made from sea-weed of two years' growth. Mr Macdonald thinks, that, in many places, too much air is admitted into the kilns at the time of burning, for the sake of doing more work in a given time; but that the kelp is never so good as when burnt in close kilns. He covers the bottom of them with sods, to prevent the gravel or sand from mixing with the kelp, in the operation of working it with the irons. Much care is taken to protect the weed, while in the course of being prepared for the kilns, from rain or night-dews, by collecting it every night into cocks, larger or smaller, according to the degree of seasoning it has got. If it has got too much sun in drying, it should be made up in large tramp-cocks, there to remain for ten or twelve days, until it gets moist again before burning.

A third specimen was sent by JOHN NORMAN MACLEOD, Esq. of Macleod, in the Isle of Skye, manufactured in 1822. This was made from cut-ware, partly of three years growth, but the greater part of only two years, by the common process followed in the Highlands.

The last specimen was sent from the shores of Lieutenant-Colonel ALEXANDER MACDONALD of Lyndale, in the Isle of Skye. This was made in 1822, from weed partly of the growth of three years, but chiefly of only two years. Mr Macdonald "always makes his manufacturers keep the sea-weed several days, say six or eight, in the large cocks, after it is dried, unless a change of weather prevent them; as he has found from experience, that it is afterwards easier reduced into a liquid state in the burning, and that the sulphur more freely evaporates, than when the sea-weed is burned immediately after it is dried."

It appears from Dr Fyfe's analyses of these four specimens of kelp, that the quantity of soda and soluble matter in each was as follows:

	Soda.	Soluble matter.
Mrs Campbell's, - -	5.4	63
Mr Macdonald's of Rhue, -	4.4	36
Mr Macleod's, - -	6.1	55
Mr Macdonald's of Lyndale, -	6.6	56

The two last specimens, though they contained the greatest quantity of soda, arrived too late; and there was some defect in the certificates required. On this account, neither of them was found entitled to the Society's premium.

PLANTATIONS.

The Society having, in 1821 and 1822, offered honorary premiums for the greatest extent of ground planted, after being well enclosed, the land to be within three miles of water-carriage, or having easy access thereto, and situated within the county of Dunbarton, the Isle of Sky, and small isles adjacent, and the Black Isle, a district in Ross-shire,—it appears from the certificates produced in claim of these premiums, that the extent planted between February 1821 and November 1822, by the proprietors to whom they were awarded in the different districts, was as follows, viz.:

There was planted by the Right Honourable Lord Macdonald, on his estate in the Isle of Skye, in new enclosures, in the parish of Sleat, 18,300 trees on about 8 acres, besides 10,000 more, which were used in making up former plantations; and at Portree, 73,800 plants in enclosures, extending to betwixt 30 and 40 acres. These plantations were all made in spring 1821, within the period fixed by the terms of the Society. In 1820, his Lord-

ship planted 47,500 trees, also in the parish of Sleat. The different fences were a stone-dike, a feal-dike, and a feal-dike with ditch and hedge. The kind of plants, and the proportion of each, was different in the different situations, those used in the greatest number being ash, elm, oak, larch, Scots, spruce, and silver firs, with a variety of other kinds in smaller proportions. The first premium for the islands was awarded to Lord Macdonald.

COLIN MACKENZIE, Esq. of Kilcoy, enclosed and planted, within the period before mentioned, 379 acres 1 rood 31 falls, in the county of Ross, consisting of

Oaks,	-	-	188,000
Scots fir,	-	-	249,000
Larch,	-	-	25,000
Alder, &c.	-	-	5,000
Ash,	-	-	27,000
Ornamental trees, chesnut, birch, &c.			7,000
		In all,	501,000

One of the plantations, extending to about 200 acres, was entirely of oak, except a belt of firs around it for shelter. This was meant as an experiment, to ascertain how far oak copses might not thrive as well in that part of the country as they do in other quarters. The plants were placed at 4 or 6 feet distant, according to the quality of the soil; all reared in Mr Mackenzie's own nursery, and their age generally two years transplanted.

The first premium on the mainland was voted to Mr Mackenzie.

Two premiums were awarded for plantations in Dunbartonshire. The first to H. Macdonald Buchanan, Esq. of Drumakile, who had planted, within the period before mentioned, 65 acres 2 roods 1 fall, with 261,000 trees; one-fourth oak, one-fourth larch, and the rest ash, spruce, and Scots firs, in equal quantities, with some willows, where the land did not admit of being fully drained: and the second to Sir James Colquhoun of Luss, Bart., whose plantations, within the period in question, extended to 61 acres 2 roods 34 falls; the number of plants being 396,900, consisting of larch, oak, and Scots and spruce firs. The fences, which were of stone,

cost - - - -	L. 159	3	4
And the drains, - -	177	6	5
Together,	L. 336	9	9

The object of the Society in offering these premiums, being to ascertain whether plantations would thrive on the coasts of the Highlands and the Western Isles of Scotland; it is satisfactory to have to add, that hitherto, there seems no reason to doubt, that these experiments will be attended with success.

DAIRY HUSBANDRY.

During the late depression in the prices of corn, it occurred to the Society, that it might be useful to obtain returns of the produce of the dairy, which, in Scotland, is chiefly confined to the neighbourhood of large towns, and some of the western counties. For this purpose, among others, they offered two premiums in 1821, for the best managed dairy of not less than six cows, in two separate districts; one of them comprehending the counties of Haddington and Linlithgow, and the other the counties of Stirling, Dunbarton, and Renfrew; and they have since extended them to other districts. The claims to which premiums have been already awarded are, one for the first district, for the year ending November 1821; and two for the second district, for the year ending November 1822. As there does not appear any thing peculiar in the management of these dairies, it may be sufficient to state here the general results only.

It appears from the affidavit and certificates produced by William Boak, tenant at Livingstone Bloom, in the parish of Livingstone, and county of

Linlithgow, that 18 cows kept by him, partly of the Ayrshire breed and partly of the breed of that district, produced in the year ending November 1821, of butter and butter-milk, as follows, viz.:

Butter 3398½ lb. sold in Edinburgh for	L. 236	9	0
130 lb. used in Mr Boak's family,	8	14	0
3528½ lb. being at the rate of near 68 lb. p. week, at 16¾d. p. lb.	245	3	0
Milk 37,800 pints sold in Edinburgh, for	188	4	0
2,555 — used in the family,	12	8	5
40,355. 110½ pints per day, a $1\frac{2}{12}$d. per pint, -	L.200	12	5
Hence the value of the butter being, -	L. 245	3	0
And of the butter-milk, - -	200	12	5
Together,	L. 445	15	5
And the number of cows 18, the value of the produce per cow, is - -	L. 24	15	3

The first premium for the second district was awarded to Misses Elizabeth and Frances Dunlop, at Househill, in the Abbey Parish of Paisley. The number of cows kept was nineteen, all of the Ayrshire breed; and the produce, as appears by an articulate statement, amounted in value to L. 302, 9s. 5d., which is at the rate of L. 15 : 18 : 5 per cow. This was for the year ending 1st November 1822. The articles were butter, milk, and cream,

of each of which a large proportion was used in the family, and the rest sold in the town of Paisley; but the prices are not specified.

The second premium for the second district was awarded to Mr John Gow, tenant in Portnellan, in the county of Dunbarton. The number of cows was 12, all of the Ayrshire breed; and the produce was sold in the state of butter and butter-milk. The returns are declared to have been at the rate of L. 10 per cow, exclusive of butter and milk used in the family, and milk employed in rearing 3 calves. This was for the year ending 1st December 1822.

In none of these communications is the expence of food and management stated, or the interest on the capital employed, or the additional allowance required for supporting the stock; so that the nett profits per cow cannot be ascertained. It does not appear that the thermometer was used in any of these dairies.

REPORT OF EXPERIMENTS

IN RECLAIMING

DRIFT OR BLOWING SAND,

AND CONVERTING THE LAND INTO USEFUL PERMANENT PASTURE,

Made by ALEXANDER N. MACLEOD, Esq. of Harris on, his Estate of Harris, in 1819 and 1820.

WE have viewed the improvements carried on upon the farm of Nisabost, in the parish of Harris, and county of Inverness, by Alexander N. Macleod, Esq. of Harris, who has completely succeeded in reclaiming and bringing into useful permanent pasture above 100 Scotch acres of useless blowing sand, by planting in it *Arundo arenaria*, well known in the Hebrides by the name of *Bent Grass*, and also by sowing *rape-seed* on it in a small proportion. The *rape-seed* requiring to be covered with sea-weed, or some other manure, immediately after sowing, is not considered so beneficial as the grass, as this requires no manure, or any other cultivation or top-dressing whatever, after being properly planted.

The operations commenced upon the above farm in the month of September 1819, by cutting the *Arundo arenaria*, or *bent-grass*, about two inches below the surface, with a small thin-edged spade, with a short handle, which a man can use in his right hand, at the same time taking hold of the grass in his left; other persons carrying it to the blowing-sand to be planted in a hole or rather a cut

made in the sand, about 8 or 9 inches deep (and deeper where the sand is very open and much exposed), by a large narrow-pointed spade. A handful of *Arundo arenaria,* or *bent-grass,* was put into each of these cuts, which were about 12 inches distant, more or less, according to the exposure of the situation. When properly fixed in the blowing sand, the roots begin to grow, and spread under the surface, in the course of a month after planting.

The *Arundo arenaria,* or *bent-grass,* may be cut without any material injury to the ground from which it is taken, as it will afterwards grow as well as if it were not cut at all.

When Harris commenced the operations in reclaiming the tract of ground alluded to, it was altogether covered with blowing sand in winter and spring, and nearly so in summer. A great part of it consisted of high banks of sand, which did not produce grass or verdure of any kind whatever.

The *Arundo arenaria,* or *bent-grass,* is relished by cattle in summer, but it is of greater value, by preserving it on the ground for wintering cattle. It would be injudicious to cut it, because it will stand the winter better than any other grass, and is seldom covered with snow. Neither wind, rain, nor frost will destroy it; but the old grass naturally decays towards the latter end of spring and the beginning of summer, as the new crop grows.

White and red clover will grow spontaneously among this grass in the course of a few years, provided it is well secured. It will produce seed in

some instances, within twelve months after planting; but the seed does not, on high exposed situations, come to the maturity that seed requires for sowing. On this account, to propagate this grass from the root, is considered preferable to sowing.

The Arundo arenaria or *bent-grass* operations, should not commence in any season earlier than about the 20th October, and should be given up about the beginning of March, as this planting thrives much better in the wet season.

Harris enclosed with palings, and planted with this grass two considerable tracts on the farms of the Bowes; and Donald Stewart, factor for Harris, also planted with the foresaid grass, a great tract of blowing-sand on the farm of Luskintyre; but as no land-surveyor at present resides nearer than Inverness, which is about 150 miles (besides ferries) from these enclosures, the expence of bringing one that distance would be very considerable; therefore we cannot state the number of acres reclaimed from the blowing or drift-sand in these enclosures. However, as we have Mr William Bald's plan and survey of the farm of Nisabost before us, we are enabled to state with accuracy, that above 100 acres, formerly of useless sand, are now in useful pasture; and from our own knowledge these eighteen years back, of the dangerous state of the foresaid tract of land to the adjoining ground, we really think that the experiment may be repeated with every prospect of success in similar situations *.

* A former report, substantially the same as the preceding,

[The following account of the plant, and of the sand referred to, in the preceding report, is taken from a communication made by a scientific gentleman * who had long resided in Harris, and seems to have paid much attention to this interesting subject.—*Ed.*]

The plant in question is a species of the genus *Arundo*, belonging to the natural order of *Gramineæ*, and to the third class of the Linnæan system. Its specific name is *Arundo arenaria*, and it is thus characterised:

A. with a spiked panicle, valves of the calyx acute, corolla nearly as long as the calyx, thrice as long as the tuft of hairs; leaves involute, pungent.

It is perennial; from 2 to 3 feet high; flowers in July. It is found in loose sand upon the seashore. The root is repent, very long, (often 20 feet). Culm stiff, with only one joint above the sand; greenish-yellow, tinged with red. Leaves very long, numerous, mostly radical, involute, acuminate and pungent. Panicle spiked, compact, linear, attenuated at each end, about 5 inches long. Calyx unequal, membranous, scabrous at the keel. Glumes of the corolla sub-membranous but stiff, nerved, roughish. Anthers large, purple. Very few of the seeds come to perfection in this country, although

dated Harris, 8th November 1822, is signed by Donald Stewart, *J. P.*, and Alexander Bethune, *J. P.*—*Ed.*

* Mr Macgillivray, Assistant to Professor Jameson.

in the north of Iceland, according to Henderson, the produce of this plant is frequently used as grain.

This plant is generally known in Scotland by the name of *Bent*; in Gaelic it is called *Muran*; on the coast of Norfolk, *Marram*. It is common on the coast wherever there is loose sand, which it seems to bind down by its long tough roots. At Aberdeen it is manufactured into door-mats, called basses; it also makes excellent floor-brushes. In the Outer Hebrides, where it is plentiful, it serves many purposes in domestic and rural economy, being made into ropes for various uses; mats for pack-saddles, bags, mats, vessels for preparing and holding grain and meal, and lastly into hats. When made into meal vessels, it is bound together by its own slender and very tough roots; but this should be prevented, as the digging for them looses the sand. These vessels are very similar in appearance to those used by the Caffres for holding their water and milk. In Holland it is planted for the purpose of binding the sands; and this practice has been introduced among us by Mr Macleod of Harris, who has tried it extensively upon his estate. *

The *sands* of the Outer Hebrides are almost exclusively confined to the west coast, being of very rare occurrence on the east, which is heathy. They do not form a continuous line, but are interrupted by extensive tracts of rock and pasture. The nature of drift-sand being sufficiently understood, it is unnecessary to enter upon its description, more es-

* This description is copied from an Account of the Plants growing in the neighbourhood of Aberdeen, not published.

pecially as the phenomena which it presents are well delineated in Dr Walker's Economical History of the Hebrides, a work replete with useful information. The sand of this interesting range of islands is essentially calcareous, being very different in this respect from that of the east coast of Scotland, as that near Aberdeen, for example, and on the shores of the Murray Frith, and Frith of Forth, which is siliceous. The latter consists chiefly of rounded grains of white quartz, whereas the sand of the Hebrides consists of comminuted shells. The origin of the quartzy-sand is commonly attributed to the disintegration of strata of sandstone, or of granitic rocks; that of the shelly sand, we know must be from the envelopes of molluscous animals. On examining the sand of Harris, we find it consisting of fragments chiefly of Mytili, Myæ, Venuses, Cardia, and Patellæ. The Patella vulgata occurs in great quantities, and at a considerable distance from the shore, in a scarcely altered state: the animal, however, being used as a common article of food in the Hebrides, the presence of these shells may, perhaps, be accounted for by this circumstance. The Mytilus edulis and Cardium edule form a prominent part: it is not easy to determine the other species, although in general it is probable that they are the same as those existing at the present day, and can scarcely be considered as of primeval origin. In some places, however, we find fragments of the envelopes of vaginated polypi, such as madrepores, and other genera, which go by the common name of Corals. This

calcareous or shelly sand varies considerably in fineness; that near the sea is in general, however, the coarsest. By the attrition which it undergoes in blowy weather, it is reduced to a very fine powder, and may be seen borne on the gale to the distance of upwards of a mile from land. It is only in the islands of Berneray and Pabbay, however, that I have observed this phenomenon.

With regard to the appearances exhibited by the Bent-grass when planted, it will perhaps be sufficient to state, that on being put into the sand in handfuls, with more or less of the root adhering, it retains some of its freshness during a great part of the winter, and in April following the young shoots make their appearance, the old grass falling and gradually decaying. There is always in bent-plantations, or in natural bent-fields, a mixture of this fresh and decayed grass in the same tufts, at almost all seasons of the year. These tufts give shelter to the sand in their immediate neighbourhood, and when pretty close, fix it completely, so that the seeds of other plants, wafted thither by the wind, germinate in it, and soon fill up the intervals. The plants which commonly make their appearance in such situations, are the Galium verum, Anthyllis vulneraria, Lotus corniculatus, Aira canina, Apargia autumnalis, Carex arenaria, Achillæa millefolium, Sedum sexangulare, Daucus carota, and several others. In process of time a permanent sward is formed, in which case, as is learned from tracts of bent in a natural state, the bent seems to diminish in vigour, giving place to a more useful vegetation.

REPORT

OF THE

Committee of the Highland Society of Scotland,

APPOINTED IN 1820 TO INQUIRE INTO THE STATE

OF

FRIENDLY SOCIETIES;

WITH

TABLES,

CONSTRUCTED FROM THE MATERIALS COLLECTED BY THE COMMITTEE.

CONTENTS OF REPORT ON FRIENDLY SOCIETIES.

TABLES.

CORRIGENDA.

Page 334, line 2d from bottom, *for* fee; *read* life;
Page 342, line 2d from top, *for* when all the members have died out, *read* when the surviving members have reached their 71st year,

INTRODUCTORY NOTE

BY

Mr OLIPHANT,

CONVENER OF THE COMMITTEE.

About twenty years ago, in the exercise of my professional duties, accident enabled me to restore a society whose name and existence had been nearly forgotten, viz. the Incorporation of Sailors of Prestonpans, and to replace the seamen of that town in the possession of their funds. The earlier records of this Society were lost, and those recovered did not contain their laws; the Court of Session directed new regulations to be framed, and submitted for their approval; and the task of framing these devolved on me. Some difficulty was experienced in apportioning the allowances to be made in future to the revenue of the society. The Revenue was to be derived from two sources; 1*st*, The interest of a capital of about L. 500; and, 2*d*, Such annual contributions as the seamen could afford. The late Reverend Mr Wilkie of Cults, a writer upon annuities, and the father of the celebrated painter, had the goodness to report upon the subject: but the contri-

butions, as proposed by Mr Wilkie, were higher, and the allowances lower, than those of neighbouring Friendly Societies; and much difficulty was felt in persuading the seamen of the propriety of the scheme proposed;—the amount of capital accumulated by neighbouring boxes* decidedly out-weighing, in their consideration, every other authority.

One seaman, who had been in three society-boxes, all of which had failed, exercised considerable influence in repressing the desire of his brethren for high allowances; and finally matters were arranged on a medium between the scheme of Mr Wilkie and the practice of the neighbouring societies. Mr Wilkie had stated the impossibility of establishing accurate calculations for Friendly Societies' schemes, till the average rate of sickness among mankind should be ascertained. He proceeded on the supposition that one-twelfth part of the members would be constantly sick. This proportion, according to the experience of the Society, has proved too high; for, notwithstanding the allowances established are higher than those proposed by Mr Wilkie, the society now possesses a revenue of L. 50 a-year from land purchased, and a small sum laid out at interest; and, calculating by the Tables subjoined, it is found to be in a condition to fulfil its present engagements for sick allowances, funeral money, wi-

* This word is used in Scotland to denote the Funds of a Society, sometimes the Society itself. Thus, we say the Trades' Box, the Poors' Box, &c.

dows' pensions, and aids to orphans. On the other hand, the affairs of the neighbouring societies, whose example was recommended as a guide, have fallen into disorder.

More recently, while residing in the country, having been requested by the members of a Friendly Society in a neighbouring village, who had taken alarm from the decline of their stock, to advise what increase of contribution might be held adequate to secure the permanence of their scheme, the practical inconvenience resulting from a want of knowledge of the probable rate of sickness was again pressed on my attention; and the impression was strengthened by previous observation of the distress resulting from the miscalculation of Friendly Society schemes, and by the recent hardship arising to a meritorious individual, who, after having been 40 years a contributor to a box, without having ever drawn any allowance, had become bedrid; and, by the shutting of the box, being left destitute, was reduced to pauperism and to dependence on the charity of the parish.

At a conference with Mr Smith of Deanston, and with Mr Maclaren and Mr Beattie, the very intelligent Directors of the Deanston Society, whose questions I had been unable to answer satisfactorily, the propriety of a public inquiry to ascertain the average rate of sickness was suggested. Many were better qualified than myself to take the lead in such an inquiry; but not being able to prevail with any of the gentlemen to whom I applied for this purpose, I ventured, though indeed with much hesitation, to

bring forward a notice of the case in the Highland Society, with an humble suggestion that this Society should agree to offer premiums to Friendly Societies for returns of the ages of their members, and the sickness corresponding to those ages: The motion being adopted, a committee was appointed to conduct the inquiry.

The motion, as originally made, was merely to obtain certain *data*, leaving their application to others; but the motion ultimately adopted being declared to be for "enabling the Highland Society to suggest a remedy" for the evils consequent on the erroneous constitution of Friendly Societies, it became necessary to exhibit the application of the *data*, if obtained.

A schedule of the information wanted, and an exemplification of a method of supplying it, both of which were arranged by Mr Alexander Will, of the Customs, having been circulated throughout Scotland, numerous and elaborate returns from Friendly Societies of the ages and sickness of their members were received; and Mr John Lyon, Governor of Watson's Hospital, after examining and digesting these returns, has had the goodness to institute computations, applying the knowledge thus obtained to the schemes of Friendly Societies.

The Committee has been favoured with communications from many gentlemen who took an interest in the inquiry; and particular acknowledgments are due for those received from Thomas Peregrine Courtenay, Esq. M. P. Secretary to the India

Board of Controul; Dr Hamilton of Aberdeen; the Reverend Dr Henry Duncan of Ruthwell; Patrick Cockburn, Esq. Accountant in Edinburgh; and Mr James Skirving, of the Stamp-office, Edinburgh.

Having been induced, by the circumstances above related, to move for the inquiry, and, as Convener of the Committee, having given my attention to the conduct of its details, my duty brought me forward, (according to ordinary usage), to state its results; it being proper that there should not be wanting some personal assurance that reasonable pains have been taken to avoid error.

EDINBURGH,
March 12. 1824.

REPORT, &c.

There are numerous instances to be found, among the labouring classes, of honourable minded men, who, at an advanced period of life, and when the evil is past remedy, are reduced, however reluctantly, to the necessity of stooping to receive the aid of parish charity, owing to the failure of Friendly Societies, to whose funds they had contributed regularly during the whole period of vigorous life: a contribution made at the expence of many privations perhaps, but at the same time in the confident assurance of thus securing to themselves the object of their highest ambition,—an independent support during sickness, and old age. The observation of the frequency of such distressing occurrences gave rise, in 1820, to a motion in the Highland Society for an inquiry to ascertain the causes of the very general miscarriage of Friendly Society Schemes.

General Diffusion of Friendly Societies.

Friendly Societies are widely diffused throughout the United Kingdom. In Aberdeenshire alone, the regulations of upwards of 200 Societies have been confirmed by the Justices of the County since 1793.

In the Edinburgh Review (Article 9.) of January 1820, these institutions are stated to include one-eighth part of the whole population of the Empire, and to distribute upwards of a Million and a half annually. Their chief object is to aid their members when incapacitated for labour by sickness, accident, or the feebleness of age.

Systems of Insurance.

The general exposure of numbers of persons to a common danger, conjoined with the uncertainty as to the individual on whom the unfortunate lot may fall, led to the establishment of systems of insurance as means of alleviating the pressure on individual sufferers. A common fund is raised by the contributions of many exposed to the common misfortune, each contributing according to his risk; and from this fund relief is afforded as matter of right to the individual who happens to be the sufferer. Fire Insurance and Sea Insurance compensate the loss or destruction of property by fire, shipwreck, or capture by enemies. Life Insurance provides for the widow, the children, or others dependent on persons whose professional or other incomes terminate at their death. Health Insurance-schemes, such as the Friendly Societies of Scotland and the Benevolent Societies of England, provide relief in the event of Incapacity for Labour. Life Insurance depends mainly on the rate of mortality; Health Insurance on the rate of mortality and the rate of sickness combined.

The insurance of property is an ancient institution. Life Insurance is of more modern growth, and until after the middle of last century its principles seem not to have been reduced to practical accuracy. The work of Dr Price shews, that the schemes, in his time, in consequence of being founded on erroneous principles, went to ruin. The Scotch Ministers' Widows' Fund, established about the middle of last century, appears to have been one of the first institutions of this nature founded on just principles. A comparison of its capital, as previously computed, with the actual amount, as afterwards ascertained by experience, from 1748 to 1788, a period of 40 years, affords the following results:

	Computed Capital.	Actual Capital.
1758,	£47,401,	£47,313
1768,	61,863,	62,610
1778,	71,560,	75,088
1788,	80,320,	86,403

The Life Insurance scheme, as applicable to the interests of the higher and wealthier classes might be expected, according to the ordinary course of things, to reach practical maturity at an earlier period than the Friendly Society scheme, which concerns the labouring and highly valuable, but less wealthy, and less educated, classes of the people.

Imperfection of Friendly Society Schemes.

Until the Life Insurance schemes had attained practical accuracy, the Health Insurance scheme, dependent on the same principles, could not be matured. The improvement of the former paved the way, in so far, for that of the latter; but, into the computation of the latter, there entered an additional element, viz. the rate of sickness among human beings; and this rate remained to be ascertained.

Friendly Societies, thus left to the guidance of conjecture, at their outset, were unavoidably exposed to error. Their schemes have very generally misgiven; but their experience lays the foundation of a more correct system, by affording data for computation which could not perhaps have been attained through any other medium. Their errors are matter of no reproach. The spirit is to be admired, which, revolting at the humiliation of depending upon charity, led their founders, seeking for the means of independent support in sickness and in old age, to endeavour to attain the desired end, regardless of the dangers of miscarriage.

Attempts to improve them

The reluctance to give publicity to their transactions, a feeling very generally diffused, though now somewhat on the wane, and which cannot be justly blamed, how much soever its existence is to be regretted, has operated with Friendly Societies to their own detriment. A knowledge of the rate of

sickness among their members, as ascertained by their own experience, was necessary to the just computation of a Friendly Society scheme; but the information was withheld by the very persons most interested in affording it, who seemed not aware of the importance of ascertaining the fact on a broad basis, and not to understand that the information was desired with a view to aid their meritorious endeavours to provide for their own independent support.

Sir Frederick Morton Eden, who has published some notices respecting Friendly Societies, the materials of which he did not obtain without considerable difficulty, justly complains, "That the persons entrusted with the management of the funds of a box-club, are even more reluctant than parish-officers to gratify that curiosity which solicits information respecting receipts and disbursements."

The Reverend Dr Henry Duncan of Ruthwell in Dumfriesshire, well known from his exertions in systematising the Savings Bank Institution, says, in a communication with which the Committee has been favoured, "I have myself experienced the difficulty of obtaining the information required, having, some years ago, made considerable efforts for this purpose, but without success. Indeed, no private individual is adequate to the task; there are so many prejudices, as well as so much indolence and indifference, to overcome."

On the usefulness of such institutions, and the disadvantages under which they still labour, Dr Duncan remarks, "It must be sufficiently obvious

that a labourer, or servant, or a mechanic, cannot, by the utmost exertions of his honest industry, accumulate any considerable sum in a Bank for Savings in a very short period of time; and that it is only by the unremitting labour and frugality of a series of years, that he can hope by this means to raise himself above the fear of want. If a depositor should fall sick before he has laid up a sufficient fund for his maintenance, all his deposits will, in a few weeks, or at most in a few months, be exhausted, by the suspension of his earnings, and the expenses attending a sick-bed, and he will be thrown upon the world without a shilling. A Friendly Society operates in a different manner, and supplies the very desideratum which is here required. It is, in fact, an insurance against incapacity for labour. When a member of such an institution falls sick, he immediately receives a weekly allowance, which enables him to subsist, if not comfortably, at least without having recourse to the parish; and should he have previously deposited any money in the bank for savings, even that fund may probably remain untouched. It appears, therefore, that the system which wisely proposes to assist the industrious class in providing for their own support, would be incomplete, without calling in the aid of these institutions, which, in place of being rival and incompatible establishments, stand in absolute need of mutual support and co-operation. The want of some Standard, however, by which the capability of a Friendly Society to fulfil its engagements could be ascertained,

has, in the result, proved highly detrimental. The encouragements held out by these institutions, which were naturally fixed on at random, have actually been found to be much too high for securing their permanent solvency, and the hopes of their supporters have consequently been disappointed. Within the last ten or twelve years, the greater part of these associations for mutual relief has been broken up, on account of a deficiency of funds; and those who depended on them for assistance in old age, have had the misfortune to experience the abortive nature of their expectations, at a period of life when that misfortune could no longer be repaired. This is a serious evil in itself, and it is not less so in its consequences. The calamities which have so generally befallen Friendly Societies, have been supposed to arise from some principle of destruction necessarily inherent in the system; and a prejudice has thus been unhappily excited against the whole scheme of mutual assurance amongst the industrious classes."

A similar desire to encourage the diffusion of these valuable institutions, by assuring their permanence, induced Mr Courtenay, Secretary to the India Board of Controul, to introduce a bill into Parliament, for instituting an inquiry to ascertain the causes of the general ruin which befel them, and to suggest remedies to prevent its occurrence in future. The motives of this benevolent measure were misrepresented or misunderstood. In England, many Societies, actuated by

by groundless alarms, dissolved themselves, and divided their funds; and, finally, the bill was abandoned. In Scotland a similar alarm prevailed; meetings were held,—a copy of the bill was obtained, and similar dissolutions were prevented only by the discovery that the bill was confined to England.

Although these benevolent efforts in favour of Friendly Societies did not attain their end, they were not without their use. The attention of their more intelligent members was excited to trace the causes of past miscarriage. The continued decline in the state of their affairs favoured the inquiry. Papers were written by members and read at Society meetings on the causes of the decline of their affairs; and some public-spirited individuals in the village of Methven in Perthshire, instituted a survey to ascertain the sickness, for one year, among the whole male population of the parish above 15 years of age, with a view to obtain *data* for calculating the scheme of a Friendly Society *.

Such was the state of public feeling on the subject, when the Highland Society instituted their inquiry. A schedule for obtaining returns of the Ages and Sickness among the members of Friendly Societies

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* In the Report of this Survey communicated by Mr Richard Wilson, Schoolmaster at Methven, it is stated to have been ascertained, that from mental or bodily imbecility, 1 in every 21 of the male population of this parish could not, at any time of their lives, have been admissible into a Friendly Society, the rules requiring entrants to be of good constitution, and capable of earning a livelihood.

was circulated; and, in 1820, two premiums were offered for the most valuable returns.

Inquiry.

Although the prejudices against such an inquiry were shaken by the previous attempts which have been noticed, they were not eradicated: meetings of Societies were held; it was resolved and declared by some that the inquiry was sacrilegious; by others that it must have a sinister object; and by a third class that no advantage could result from it. Several societies, actuated by more enlightened views, intimated their desire to forward the inquiry, but stated that their books had not been kept in a proper manner to afford the results desired. This was a general objection, and it presented a great difficulty. After mature deliberation, the Committee of the Highland Society circulated an Exemplification of a method, by which, in the existing state of society-records, the results might be found, though certainly not without considerable labour; and, through the industry and zeal of the members of Friendly Societies, the Committee are now in a condition to review the experience of upwards of 70 societies for periods of 3, 10, 20, 30, 40, or 50, years *.

The inquiry was confined to the age and sickness of the members and was not extended to *deaths*,

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* The first Premium was awarded by the Highland Society to Mr Thomas Dixon, stampmaster in Dunse; and the second to Mr Gavin Burns, surveyor in Hamilton.

from reluctance to load returns otherwise sufficiently difficult. But information from Friendly Societies, on the mortality experienced among their members, would have been of much value amidst the great diversity of results exhibited by the existing tables of mortality; and also from the consideration that the general rate of mortality in the community at large, including persons of sound and unsound constitutions, though it were ascertained with perfect accuracy, cannot represent with entire precision its rate in societies whose laws debar admission to persons of unsound constitutions. And being now satisfied that a return of deaths, though not indispensable to the object in view, would have been very desirable, and as, upon retrospect, it has appeared of more easy accomplishment than was at the time anticipated, it is a subject of regret to the Committee that such a return was not required.

The Committee purposely abstained from desiring returns of the Funds possessed by the Friendly Societies, being unwilling to excite the jealousy which any inquiry into their pecuniary affairs so readily creates. The information desired was entirely confined to *time*; the ages of members, and the number of weeks of sickness at each particular age; this information, combined with the tables of mortality, affording the means of calculating the sick allowance which a given contribution can afford. The Committee, however, have been favoured with copies of the printed regulations of a number of societies, which exhibit the system of contribution and distribution on which these societies at present proceed.

Returns of Sickness.

The appellation of "Highland Society," seeming to denote a limitation of object, may convey, to those unacquainted with Scotland, an idea that the inquiry has been confined to the rate of sickness in the mountainous districts only. But it embraced Scotland in general, and gives the rates of sickness chiefly of the lowland and more densely peopled districts, these being more favourable than the mountainous and thinly peopled districts to the establishment of such institutions, which chiefly abound in the agricultural, commercial, and manufacturing counties.

Returns to the Schedule issued by the Highland Society have been obtained from Friendly Societies in sixteen out of the thirty-three counties of Scotland, viz. Ayr, Berwick, Cromarty, Dumfries, East Lothian, Edinburgh, Forfar, Lanark, Linlithgow, Peebles, Perth, Renfrew, Ross, Roxburgh, Selkirk and Stirling.

A summary of the Results of the Returns is subjoined to this Report.

Viewing the results generally, it appears that, from 20 to 50 years of age, the sickness increases gradually with the advance of age. The quantity of sickness is pretty nearly, although not exactly, *one-tenth* part of a week for every *five* years of age. Thus, in the decade (or period of 10 years) from 40 to 50, it amounts to somewhat more than *one week* annually to each individual. But in the next decade, from 50 to 60, the sickness approaches to the *double* of this amount,

being nearly *two weeks* annually to each individual. In the decade from 60 to 70, the advance in the rate of sickness is still more rapid; as, compared with that of the former decade, it is nearly *trebled.* From 60 to 70, the sickness is nearly *six* weeks annually to an individual. According to the subjoined Table, being No. 3. of Preliminary Tables, the total sickness to an individual for 50 years, viz. from the commencement of the 21st, to the completion of the 70th year of age, is nearly *two* years.

The following is the average annual sickness to an individual, according to the Friendly Society Returns *.

Age.			Sickness expressed in Weeks, and Decimals of a Week †.
Below 20	-	-	0.3797
20 to 30	-	-	0.5916
30 40	-	-	0.6865
40 50	-	-	1.0274
50 60	-	-	1.8806
60 70	-	-	5.6337
Above 70	-	-	16.5417

* This exhibits the average sickness of the several *decades* from 20 to 70. The sickness when exhibited for *each particular year* of age, as is afterwards done, is somewhat less in the first years of the decade, and somewhat more in the concluding years, than this medium rate.

† These denote so many *ten thousandth* parts of *a week.* The minute parts of money are expressed, in like manner, in ten thousandth parts of a pound. If occasionally the decimal figures are carried beyond four from the decimal point, in considering the product the remoter figures may be disregard-

For more particular information on this subject, reference is made to the Appendix No. 2., which contains, among other articles,

1*st*, The *Schedule* and the *Exemplification* of a method of collecting the requisite information *. These may be useful to societies who have not hitherto reviewed their own experience, but who may be desirous to do so before trusting to the experience of others. To societies who shall in future institute such an investigation, it is recommended to ascertain, also, the ages of their members at death, for which an additional column may be prepared; and the column for the average age, as occasioning much trouble, without any correspondent advantage, may be omitted.

2*d*, An *account*, containing the names of the Friendly Societies by whom returns have been made,—the counties in which they are established,—a digest of the number of members, ages and sickness in the several societies,—and the names of the persons to whom the Highland Society has been indebted for reporting the several returns.

3*d*, An *account* exhibiting the average annual sickness of an individual in *each* society which has

ed. To bring the decimals always to ten thousandth parts, the decimal figures must be held as completed to the fourth place by ciphers, although they are left blank. Thus, for example, .936, must be held to have a final 0, and be viewed as .9360.

* The advertisement by the Highland Society for information on the subject is already published in volume 5th of their Transactions.

made a return; the statement in each decade, (or period of ten years), commencing with the society that exhibits the highest rate of sickness, and concluding with the society which exhibits the lowest. It would be interesting to ascertain how far health is dependent on the avocations of individuals; but, with few exceptions, Friendly Societies are composed of persons of different callings. It would also be desirable to know how far health is dependent on residence in town or country; but while the materials for such investigations, so far as they have been supplied in the present inquiry, have been faithfully exhibited, to enter here upon further discussion on that subject would be foreign to the object immediately in view.

4th, An *Abstract* of the regulations of various Friendly Societies, so far as regards their contributions and allowances, is also annexed; and this may be held to exhibit the present system of those societies. It is not meant to offer any observations upon the particular schemes, but merely to afford the means of comparing different schemes, ascertaining which is best, and considering how far the system of contributions and allowances followed is correct or defective.

Importance of ascertaining the rate of Sickness.

No general inquiry for ascertaining the proportion which the period of health among human beings bears to the period of sickness, had previously been instituted in this or in any other kingdom, so far as

the Committee has been able to learn. But the subject seems to merit inquiry, both in a speculative and in a practical point of view. It is interesting to the statesman, to the medical inquirer, and, above all, to the great class of society, whose daily food depends upon their daily labour. The knowledge is interesting, considered merely as an historical fact connected with our species; a fact not uniform in its amount, perhaps, even in the same country, at every period, but varying in the periods of each country's progress from the rudeness of savage life to the highest period of its civilization.

The changes which daily take place around us are not limited in their operation to the immediate and visible effects which they produce; they operate upon the whole frame of society, by connections impossible to be traced beforehand in all their various combinations, and difficult to be followed through all their various links, even after their effects are distinctly seen; each successive effect becoming, in its turn, a cause, exercising new influences, and leading to new results.

The climate, the condition of the territory of the state, the manners of its inhabitants, the degree in which they are supplied with food, may probably vary the proportion between health and sickness; but in considering the condition of a state, in connection with the comfort and happiness of its members, it is a matter of interest to know, under what circumstances of its progress the people have been

found to enjoy the greatest proportion of healthful existence.

The diseases, to which the inhabitants of a country, in some of the usual stages of its progress, become liable, often disappear or become modified, without the intervention of human agency. In other cases, human agency is called forth, with a view either to moderate their violence, or to change them to a character less fatal in its consequences. Investigations in detail will sometimes enable intelligent men to trace some of the secondary changes up to the primary, in which the new impulse had originated. In ascending, however, through a series of particular to general causes, it is not unlikely that links and connections, which may considerably vary the result produced by the more obvious and leading agents, may sometimes be overlooked, and false conclusions consequently drawn, respecting the relations between the causes and their effects.

The clearing of forests, the draining of marshes, the better arrangements of society, the less frequent occurrence of famine, the more general habits of cleanliness, better dwellings, and more comfortable apparel, may each have exercised their partial influence upon the duration of human life, as well as upon the periods of healthful existence.

The discovery of new and valuable medicinal substances, improvements in the theory and practice of medicine, the more extended knowledge of the human frame in its connections, dependencies and modes of operation, may also have led to important

consequences. The introduction of inoculation, and more lately of vaccination, if it has not diminished the *quantum* of mortality among children, has at least diminished the *quantum* of suffering, and the *quantum* of deformity, to which they had been previously exposed, by the ordinary small-pox. The accumulated effects of these causes, as jointly co-operating on the whole period of human life, whether as to its total, or as to its healthful period of duration, have not hitherto, perhaps, been fully ascertained.

To the medical inquirer, then, who traces the remote as well as the proximate causes of disease, with a view to discover means for its prevention, it will be interesting to know the aggregate sum of the operation, which the changes of system or of circumstances have, from time to time, produced on the relative proportions of human life passed in a state of health and of sickness. Such an inquiry, repeated at intervals, would thus seem desirable, in order to exhibit, in a comprehensive form, a general view of the final results of all the various operating causes, both in their immediate and remote consequences, upon the duration of life, and on the health of the inhabitants of the kingdom at large.

To that numerous and valuable class of the community, whose means of support depend on daily labour, such results are of great importance. Incapacity for labour constitutes the common danger to which this class is exposed, and an ascertainment of its rate, on correct principles, can only be

obtained, *first*, By a knowledge of the aggregate amount, and the duration of the common danger to which the class, as a body, is exposed; and, *secondly*, By apportioning to each individual, composing the class, that quantity and proportion of the common danger that will fall to his share, upon an equal division. By the acquisition of accurate information upon these data, any given number of individuals may form a society for supporting each other in the periods of sickness, and for regulating, according to the difference of age, the sums to be contributed to its funds.

Friendly Societies give the best Approximation to the general Sickness of the Kingdom.

With regard to the inhabitants of the kingdom at large, it is not possible, perhaps, to ascertain, with any degree of accuracy, the general result of a number of facts of different kinds, and depending upon a diversity of circumstances of hourly occurrence in the varying health of the several individuals of so large a mass. It becomes therefore necessary to confine our attention to some given portion of the people, and from thence to draw our inferences with respect to the whole. In selecting the portion, from whose quantum of sickness we propose to draw any thing like a general conclusion, it is necessary that the quantum of sickness of that portion should be accurately ascertained; and that the portion selected should consist of such a number of in-

dividuals, as to exhibit, by approximation, a tolerably fair representation of the community at large. From want of records as to female sickness, generally, and as to males before puberty, the attention must be confined to the sickness of males after puberty. The three bodies of men, as to whose members the occurrence of sickness, exclusive of infantile diseases, has hitherto been most correctly ascertained, are perhaps the soldiery of the kingdom, the seamen of the Royal Navy, and the members of Friendly Societies. So far as the requisite of a correct statement of the actual sickness is concerned, they perhaps stand nearly on a par; but the two former are exposed to contingencies from war and climate, from which the general adult inhabitants of Britain are exempted. Laying such contingencies aside, there is a circumstance which seems to render the two bodies first mentioned less fit to be considered as representing, by their sickness, that *quantum* of sickness which may be expected among the people in the aggregate, namely, that those received into the service undergo a scrutiny so very strict, that the persons admitted must, under ordinary circumstances, be expected to exhibit a much less proportion of sickness than can well be supposed, under the same circumstances, among the general body of inhabitants of the kingdom. Friendly Societies are liable to a similar objection, but in a less degree; for, in practice, the scrutiny is less severe at admission, and the rejections much fewer. Although the census made in the parish of Methven, ascertains that one in twenty-one

nearly of the males, above 15 years of age, could not, at any period of their lives, have been admissible into a Friendly Society; yet the scrutiny there, as may reasonably be supposed, was not either so minute or so rigid as that which happens daily in the military service. The Committee has been favoured with a "Return of the number of recruits for the army, inspected at Glasgow, from the 1st January 1817 to the 20th June 1823, divided into annual periods, wherein the number deemed fit for the service are distinguished from those considered to be unfit, with a specification of the causes of rejection." In 1817 there were,

Numbers inspected, - - -		613
Deemed fit for service, -	506	
Deemed unfit for service, -	107	
		613

In the subsequent years, the proportion rejected is often greater, and not in any case less. The Committee have not had an opportunity to see any similar report from the Navy. This return, however, applies to a period of peace, when rejections might be more frequent; but still it seems probable, that in peace and war, the strictness of scrutiny, with respect to the constitutions of persons admissible into either the Army or Navy, is greater than that which is usually observed with regard to entrants into Friendly Societies; and thus the sickness among the members of Friendly Societies will, perhaps, upon the whole, give the nearest attainable approximation to the de-

gree of sickness actually existing among the adult inhabitants of the kingdom at large; though, after all, it will certainly be somewhat too low.

Statutory Regulations.

The principle on which Friendly Societies must be constituted, in order to permanence, is thought to be this,—that the contributions of the members, taking them on an average, shall, upon the whole, be equal to the allowances to the members, taking them on an average. From past failures, it may be inferred, that hitherto the contributions and allowances have not been regulated in just proportion to each other.

In 1773 and 1789 Friendly Societies attracted the attention of the Legislature. At the request of a Committee of the House of Commons Dr Price made computations on the subject. (Appendix to 7th Edit. of Dr Price's Work.) These, though confessedly founded on suppositions, the actual rate of sickness being unascertained, are highly valuable, but being given in a work of an abstruse nature, with which members of Friendly Societies are little conversant, they have not met with the attention which they merit.

Since the year 1792 several Acts of Parliament for the encouragement of Friendly Societies have been passed*. Such Societies are declared to be "law-

* 33d Geo. III. cap. 54.—35th Geo. III. cap. 111.—43d Geo. III. cap. 111.—49th Geo. III. cap. 125.—57th Geo. III. cap. 39.—59th Geo. III. cap. 128.

ful," their rules being exhibited to the Justices of the Peace, and confirmed by them at the "General Quarter Sessions of the Peace for the County, Riding, Division, or Shire;" and no rule can be altered without the concurrence of three-fourths of the members present at a general meeting of the Society, convened in terms of section 3d of the statute first mentioned, and the subsequent confirmation of the Justices. Societies are authorised to prosecute their Treasurers to account for the funds, in the Supreme Courts of England, Scotland, and Wales, free of expence; and if any office-bearer entrusted with the funds dies, or becomes bankrupt, the claim of the Society is to be satisfied in preference to other debts. All disputes between societies and their members are determinable by the Justices of the Peace, without appeal, unless the regulations appoint these to be settled by arbitration, in which case, the decision of the arbitrators is declared to be final.

The last statute on the subject was passed in 1819. It sets forth the desirableness of protecting Friendly Societies against the effects of "fraud or miscalculation" and provides (section 2.), that "Justices shall not confirm and allow any tables of payments, or benefits, or any rules dependent upon or connected with the calculation thereof, until it shall have been made appear to such Justices, that the said tables and rules are such as have been approved, by two persons at the least, known to be professional actuaries, or persons skilled in calculation, as fit and proper,

according to the most correct calculation of which the nature of the case will admit."

It is declared lawful (section 3.) for the "Justices assembled at the General Quarter Sessions of the Peace, for any County or Riding in England or Wales, from time to time, to make and publish such general rules for the formation and government of Friendly Societies or Institutions, under the authority of this act, as to such Justices may appear fit, and to require, that the rules of all Societies thereafter established within such county or riding, shall be made conformable to such general rules; and it shall also be lawful for such Justices to declare, that the rules proposed for the formation of such Friendly Societies or Institutions, which shall be made conformable to such general rules, may be exhibited to, and confirmed by, any two or more Justices, holding petty sessions within the division wherein any such society is to be established."

It is further provided by this statute (section 14.), that where the trustees for a society become apprehensive that the funds "are likely to prove insufficient, to make all the payments becoming due to the several parties interested, according to the rules of such society, the said trustees shall forthwith state their apprehension, and the grounds thereof, to the Justices in General or Quarter Sessions, or if the rules of such Institution shall have been originally confirmed at the petty sessions, then to the Justices in such petty sessions; and it shall be lawful for such Justices, upon a full statement of the accounts and

proceedings of such societies, which the said trustees are hereby directed to furnish at the requisition of such committee, to make such order for the adjustment of the claims of all parties interested in the funds of such society, as to them may appear fair and equitable," power being given to parties aggrieved to appeal to the next Quarter Sessions, whose decision shall be final.—The last statute does not extend to Scotland.

Revenue, &c. of Societies.

The Funds of Friendly Societies generally arise from two sources; entry money paid by members, and fixed future contributions, of the same rate, by all the members.

Their Expenditure chiefly consists of sick allowances to their members,—allowances for the funerals of members, their wives, and widows;—an annuity is frequently provided to widows, and more rarely an allowance is made for orphan children.

Regulations.

The Regulations of societies establish their particular contributions and allowances; and in other respects regard generally the age of admission, the place and times of meeting, the appointment of office-bearers, the investment of their surplus funds, and forfeiture by the members of the privileges of the Institution, in case of non-payment of contributions for a stated period. Such forfeitures for non-payment are generally found in insurance schemes,

and these appear to be indispensable in Friendly Societies, being, in truth, the only practicable means of enforcing regular payment of small contributions.

Circumstances which govern the proportion between the Contributions and Allowances.

In many of the arrangements of Friendly Societies, there is an option: the same matter may be managed in different ways. But there are other particulars connected with such institutions, which admit of no option, where the laws of nature regulate, and the members have no choice. In their arrangements, they must conform to the laws by which life and health are found to be governed, or undergo the penalty of violating laws which they cannot elude.

To view Friendly Societies in their simplest form, and as confined to relief of their sick members alone: whatever be the regulations in other respects, the Society cannot be permanent, unless the contributions of the individual members during life, one with another, (regard being had to the accruing interest), be *equal* to the whole allowances derived by individual members during life, taking them also one with another. But it may be asked, How is this proportion to be found?

Viewing a Friendly Society as a mass, consisting of a number of individuals of different ages, varying from time to time in its members and numbers,—old members dying, new members entering,—but the society still continuing, the enquirer is apt

to feel somewhat bewildered; to hesitate where to fix his view; where to commence, and where to conclude his calculation. But from viewing the society in the aggregate, let him proceed to consider this mass as composed of individuals, *each* of whom enters at a given age, contributes on one hand, and receives aid on the other during life, and finally dies. Were the progress of a number of such individuals in any society to be traced, and were it found that all they had paid in during life, was equivalent to the whole that they had drawn out, it might safely be inferred, that, so far as these persons were concerned, the contributions and allowances were in just proportion to each other in that society. This ascertainment could not be effected until all the individuals comprehended in the calculation were dead, and it could not be affirmed with certainty, that, under the same system of rules, the like result would be found to follow, upon tracing the progress of an equal number of other individuals in the same society. But supposing such a calculation of the progress of other individuals to be actually made, and the same result to be again found to arise, then the probability would be strengthened, that in this society the contributions and allowances were, upon the whole, in just proportion one to another; and, according to the number of calculations followed by the same result, the confidence in the justness of this conclusion would be increased. Still the calculation would proceed only on inference and pro-

babilities; inferring, that what in time past has been found adequate, will be found to be so in time to come; and, on such evidence, the calculation must ultimately rest, for it is all the evidence attainable on the subject.

Such repeated results would justify these conclusions, 1*st*, That the Friendly Society in question was established on a proper basis; 2*d*, That any other Friendly Society, established on a like basis, and in the same circumstances, will be likely to prosper.

The returns obtained to the Schedule issued by the Highland Society, do, it is humbly thought, enable the Committee to bring existing societies to a test somewhat similar, and to point out how new societies may be formed, with a likelihood of fulfilling their engagements.

For, in tracing the progress of the individuals supposed to be comprehended in the calculations from which these conclusions are drawn as to the society at large, let us examine what has been ascertained with regard to each of them. Supposing these individuals to have been 100 or 1000 in number, and to have entered at 21 years of age. Their numbers would diminish annually till all were dead; and, it is supposed to have been ascertained in what proportion they actually did diminish. The contribution being alike for each individual, would be governed by their number annually, and the quantum of allowances for sick money, would, generally speaking, depend on two circumstances,

viz. the *number* and the *age* of the members, sickness advancing in amount with increase of years.

Then, so far as regards the members personally it is held that there has been ascertained, 1*st*, The number alive at each period, and the rate at which they die off; 2*d*, The rate of sickness corresponding to their age. But, so far as these particulars are required in order to make computations for future guidance, they are now obtained. The tables of mortality give information on the *first* point as to persons of every age, though less satisfactorily perhaps than might be desired; and the returns of sickness, now made by the Friendly Societies, give information on the *second* point. Knowing the number and age of their members, any society can thus ascertain beforehand, the probable number and age of these members at every future period till all die out, the number of annual contributions which the society will receive, and the quantum of sick allowances with which it is probable the society will be burdened. But it may be said that the object is still unattained, because it remains still to ascertain certain rates of contribution and allowance, which will finally prove equal to one another, or which, when separately accumulated at the death of all the members, will give equal results: And it may be said, it is not shewn what these rates are. But this difficulty will be easily obviated; for by calculating what L. 1 of annual contribution paid in by each member of a society

of 21 years of age annually during life, till all are dead, and accumulated at interest, will amount to at the death of the last survivor of these members; and calculating, on the other hand, what L. 1 of weekly sick money paid to each of these members during sickness, accumulated in like manner, will amount to when all are dead; *then*,* if it be found that the amount of these two accumulations are *equal*, it may be concluded that L. 1 of annual contribution is equivalent to L. 1 of weekly sick money.

If, on the other hand, the accumulated amount of the contributions is equal to *one-half* only of the accumulated sick allowance, then L. 1 of annual contribution is only equal to 10s. of weekly sick allowance, and so on in proportion. By a similar operation, the proportional contributions and allowances commencing at any other age, may, in like manner, be ascertained. Thus, the returns of sickness, conjoined with the tables of mortality, will form a basis for instituting computations, to enable societies in future to regulate their contributions and sick allowances, with the probability that the whole contributions of the individual members during life, one with another, may be equal to the whole allowances made to individual members during life, taking these also one with another.

In like manner it may be ascertained what single contribution, paid down at 21, or any other age, will be sufficient for defraying given allowances, without any future contribution being required; and

from these computations it may be determined, by a little calculation, what sum, paid down by members at entry, will compensate for their admission at later periods of life than 21,—what sum of entry money will be sufficient to supersede a given sum of annual contribution,—and, in like manner, what annual contribution, or, in lieu thereof, what single payment, is required to be made by members to compensate any fixed payment to be made at their own death or the death of their wives, or to provide an annuity to the widows of members.

The calculations are supposed to be made upon the original members alone, who may farther be supposed to have been all of one age at the outset; and the computation is understood to be carried on according to the laws which are found to regulate mortality and sickness, until all the members die out. It may, at first sight, be thought that the results derived from such computations will not be applicable to societies, as ordinarily constituted, all of which admit new members. But the same laws of mortality and sickness being applicable to the new members, the results must also be applicable to them. In a communication from Dr Hamilton of Aberdeen, with which the Committee have been favoured, he remarks, that "The same terms of contribution and allowance calculated for a Society which admits no new members, are calculated for a Society which is continually recruited by new members of the age for which

the calculations are made, or upon payment of a proper fine, if of a higher age."

Errors into which Friendly Societies seem to have fallen.

When a Friendly Society is to be established, it is not uncommon to admit as constituent members persons of all ages, in order to swell the numbers of the association at the outset. At the same time, a limitation is established as to the age of entrants in future. The contribution is frequently too low, even supposing all the members within the limited age; but were it equivalent as for members of that age, it is still inadequate for the members of higher ages originally admitted.

The claims for sickness are much less in early than in later life. Between 60 and 70 years of age they are about *ten*-fold what they are between 20 and 30; and therefore, the surplus of the contributions of early life must be set apart, and accumulated, to meet the larger demands in future years, when the allowances will exceed the contributions. If the early surplus of the contributions of the constituent members, who enter in youth, are not thus set apart and accumulated, but, on the contrary, exhausted in defraying the larger demands of the aged members, then, when 30 or 40 years have passed, and those members who had entered the society in youth have reached their sickly period of life, a fund to meet their demands for allowance will be wanting.—

Youthful members are then sought to prop the declining society. Schemes thus constituted do not proceed on the principle of each member providing for himself, but on the principle that the youth of one generation shall provide for the aged of the generation which preceded them,—an arrangement necessarily exposed to miscarriage.

Another error, into which Friendly Societies seem to fall, consists in supposing that they can insure a sick allowance to members entering at various ages, *e. g.* at 21, at 40, or at 45 years of age, at the same rate of contribution. But supposing the contribution for sick allowance to be 5s. annually, it will afterwards be seen that this will afford the following widely different sick allowances, to each of these several members, from the time of entering the society till reaching his 70th year:

To the member entering at 21, -	L. 0	5	$1\frac{3}{4}$
———— entering at 40, -	0	2	$9\frac{3}{4}$
———— entering at 45, -	0	2	$3\frac{1}{4}$

If a further contribution of 5s. annually, from the time of entry, were made by each of these persons, to provide to each an annuity for future life after 70, the several annuities which could be afforded to them would stand thus:

To the entrant at 21, a life-annuity after 70, of - - -	L. 14	10	$0\frac{1}{2}$
To the entrant at 40, - -	4	8	9
———— at 45, - -	3	1	5

Thus, to entitle members of these higher ages to the same allowance as the member of 21, much higher contributions are required from them. To provide the same weekly sick-allowance, nearly double contribution is required from an entrant at 40, and somewhat more than double contribution at 45: and for the life-annuity, more than treble contribution at 40, and more than quadruple at 45 of the contribution requisite from a member entering the society at 21.

Another important error into which Friendly Societies have generally fallen, arises from assuming that they are rich and prosperous, from the circumstance of their capital accumulating annually and progressively for a long period of years. This circumstance, until its reasons are fully understood, is apt to create a dangerous illusion, and often leads societies to enlarge the rates of distribution, while, notwithstanding this seeming prosperity, the allowances may perhaps have been fixed higher originally than the funds could sustain in the long run.

The rate of yearly contribution in a Friendly Society continues the same for life, while the rate of sickness increases yearly from youth to age. Supposing the annual rate of sickness of an individual at 21 years of age represented by *one*, the rate of sickness from 60 to 70, on an average, will be represented nearly by *ten;* and at 70, it will be represented nearly by *eighteen*. At the latter age the sickness is about eighteen-fold the amount of that

at the age of 21. Thus, in early life, while the members are paying more than they draw out, the society will accumulate a capital: but in advanced life the members draw out more than they pay in, —and a society, though possessing a large capital, may still in fact be insolvent. For money received, the society has undertaken to pay money hereafter of greater amount; and prosperity is inferred from the possession of the sum received, without attending to the amount required hereafter, to fulfil the society's engagements to its members. Friendly Societies, seeing their capital increasing, enlarge their distributions; but in this they too often resemble the prodigal, who, having borrowed money, spends profusely, forgetful of his obligation to repay it.

Probable Sources of future Improvement in existing Societies.

It seems probable, that any tables merely exhibiting rates of contributions and allowances, however accurately constructed, will not of themselves carry conviction to the minds of members of Friendly Societies. The doctrine of annuities, on which such tables depend, is not yet familiar in this country, either to the higher or the middling classes of the people. It would be unreasonable, then, to expect either that it should be familiar to the labouring classes, or that they should acquiesce readily in inductions, while unable to follow any one step of the process from

which the induction was derived. Generally speaking, it would introduce a new idea among the members of Friendly Societies, could a belief be implanted that the schemes of these institutions are in any degree susceptible of calculation.

It seems reasonable to expect, that, among existing societies at least, a correction of the errors of their schemes, where such exist, must chiefly be looked for from their own members, and will be most effectually promoted by diffusing amongst the members, in the simplest form of which the matter admits, the materials of thinking on the subject. The ordinary processes of arithmetic, are taught in all the parochial schools of Scotland, and understood by many, if not by all the members of these societies. All societies have members, who, some from taste, many more from their occupations as schoolmasters, book-keepers, measurers, and other employments, are practically familiar with arithmetic; and in large towns, the acting as clerk to Friendly Societies constitutes, in some degree, a vocation, one individual sometimes acting as clerk to 10, 15, or 20 societies. They embrace many members highly respectable for their intelligence; and to enable the more intelligent members to trace the progress of a Society Scheme, step by step, through all its fluctuations, and to examine it in all its bearings and connections, would be advantageous. It is desirable to exhibit a Society Scheme in such a form as may be likely to extend, somewhat more widely at least, some general ideas

on the subject. If, further, it could be so exhibited, that all or most of the processes could be followed, and the rules applied by the more intelligent members of these institutions, the foundation would be laid for the introduction of an improved system among existing societies.

Every one must be content to use the means which are within his power. The zeal, industry, and intelligence of the Friendly Society member are his own; he may apply them at pleasure; but he cannot apply the smallest part of the funds to obtain the opinion of a professional accountant on the society's affairs, without the sanction of a majority of the members. To obtain this sanction, until some perception of the advantages to result from it is more generally diffused than at present, will often be impossible, and always difficult; and the Friendly Society member, desirous of ameliorating its system, will often find, that, by making himself acquainted with the leading principles of such schemes, communicating his views to the leading members of his society, and thus attempting to obtain a change of the rules, he will follow the surest, and the easiest way to his object. Ameliorations accomplished in this manner are already in progress. An Essay on Friendly Societies was lately published by Mr Gavin Burns of Hamilton *. And among many papers on the subject, written by members, and read to their societies, there have been noticed with pleasure

* Published in 1821 by Chambers and Collins of Glasgow.

those of Mr William Dick *junior* of Bathgate, and of Mr Alexander Boreland of Paisley, which display an intimate knowledge of the subject, and have produced beneficial effects on the schemes of societies in their neighbourhood.

Changes in the Character of Friendly Societies.

Friendly Societies have only attained gradually to the condition of health insurance schemes. In their origin they were charitable institutions; the amount of the fund regulated the extent of aid, and relief was afforded to such only as were deemed objects of charity. In process of time their character changed. It came to be established, that all unable to work, were entitled to demand as a debt, the stipulated allowances established by the regulations. But still the confirmed operation of previous habits and views preventing the change from becoming absolute, gave a mixed character to their schemes. Thus, their laws occasionally recognise as a merit the abstinence from claiming the stipulated allowances, while, at the same time, they specially debar the casting reproach on those who apply for and accept of aid. This mixed character seems gradually to have disappeared, and their more elevated character of insurance schemes is now generally established. Thus, the regulations of the Perth Hammermen Society set forth, that the parties "have formed themselves into a Society, with a view to mutual assistance, and *not* as a charitable institution (as some meanly

denominate societies), but out of brotherly love for one another, as each providing for himself."

In the regulations of the Dalrymple Society the non-acceptance of the allowances is specially debarred. "None are left to the alternative of applying, or not applying, as the non-acceptance would destroy the reality of compensation, and substitute the idea of charity in its place, which is not only repugnant to the scheme of the association, but would also hurt the feelings of other members."

The new principle thus introduced was a valuable improvement, but, of consequence, it was necessary to vary other parts of the scheme in accordance with this great change, and some time elapsed, as might be expected, before this became fully and generally perceived.

In the introduction to the regulations of the Hamilton Liberal Society, published in 1804, it is stated,—"Towards the end of last century, several of the old societies adopted the new principle, and corrected their regulations accordingly; and such new societies as were formed followed the new plan. One thing, however, seems to have escaped their observation, namely, that the same annual premium which was found by experience to be sufficient to support a society upon the old principle, was by no means adequate to the same purpose on the new plan. They made no alteration on their annual premium; whereas it would have required at least to have been doubled, if not more. If, in order to give 3s. or 4s. a-week to those only whom the socie-

ty judged to be proper objects of charity, an annual premium of 2s. was required from each member; then, in order to give the same weekly to every member without distinction, an annual premium of 4s. or 5s. would be necessary."

Their Failure partly occasioned by Improvement in their Principle.

The disorder which has prevailed in the affairs of Friendly Societies seems thus, in some degree, to have been the consequence of an improvement in the principle of their schemes, unaccompanied with the corresponding changes which that improvement required in their various parts. It seems to follow, that the records of Friendly Societies cannot, in all cases, be held to exhibit the absolute quantity of sickness among their members, but only that part for which allowances have been demanded. And, accordingly, in societies where all entitled to claim have not been in use to do so, the persons reporting the returns of sickness have corrected them by suppositions, making an addition to the quantity of sick allowances actually paid, for that sickness for which it is supposed no allowance was demanded.

PRELIMINARY CONSIDERATIONS BEFORE INSTITUTING COMPUTATIONS FROM THE RETURNS.

Before instituting computations from the returns obtained by the Highland Society, there were various points necessary to be fixed. 1*st*, The age of members at which the computation should commence. 2*dly*, The mode in which the financial affairs of a Friendly Society, both in its general progress, and its particular details, might best be exhibited to view. 3*dly*, Whether the contributions by the members should be held as payable during life, or only during the period of health. 4*th*, Whether the sick allowances should be assumed as temporary, existing only for a given period, or continued during the whole period of sickness or incapacity for labour. 5*th*, Whether the computations should be founded upon one average rate of sick allowance, or upon particular rates, regulated by the intensity, or by the duration of sickness. 6*th*, Whether the whole allowances should be calculated on the principles applicable to sick allowances, or partly as allowances receivable during sickness, and partly as life-annuities to superannuated members receivable during future life, after some given age. 7*th*, Whether a widow's provision should be contemplated as a part of a Friendly Society scheme. 8*th*, The Table of Mortality to be selected as a basis of computation was a point of important consideration;

and, *lastly*, The rate of interest to be assumed in accumulating the Funds of the Society.

I.—It was finally resolved to institute the computations as upon members of a society commencing the 21st year of their age. At this age, the labouring classes are in full bodily vigour; and, generally speaking, in their greatest state of opulence, the charges of a family scarcely having begun. The contribution commencing at an early age, is diffused over a long period of time, is lower in annual amount than if its commencement were deferred to a more advanced age; and bears lighter on the member in future years, when the charges of a family might render inconvenient the payment of a large annual contribution, and eventually, from its heavy pressure, lead the members to forego the advantages of the institution. It was a further motive for the selection of this early period for commencing the computation, to be thus enabled to exhibit the increasing rate of annual contribution required at every later age.

II.—In order to exhibit, in the simplest form, a view of the course of affairs in a Friendly Society, it was resolved to adopt the *supposition* of a society of persons entering in the 21st year of their age, and continuing united till all the members may be supposed to be dead; the society to consist of 1000 persons on an averge, during its first year, and to admit no future entrants. In tracing the progress

of this society year by year, till all its members, according to the Table of Mortality, may be supposed to be dead, there is seen the accumulation of its stock for a long period; then its diminution; and at the death of the last member its final extinction. Hence the means are given to draw conclusions applicable to all Friendly Societies, at whatever age entrants are admitted. For, as already mentioned, the same terms of contribution and allowance calculated for a society which admits no new members, are applicable to a society which is continually recruited by new members of the age for which the calculations are made, or to a society admitting members at later ages, upon payment of a proper fine or equalising payment.

III.—In considering the circumstances of the annual contribution by members with reference to the period to be assumed for its duration, it is found that the practice of societies on this point is not altogether uniform, but in general all members contribute, whether sick or in health, at one uniform rate.

In the present computations it has been deemed right to assume, that all members during life, from 21 to 70 years of age inclusive, contribute, whether sick or well, at one uniform rate, and that all cease to contribute on completing their 70th year.

IV.—Some diversity of opinion prevails on the point, whether such institutions ought to provide for

the whole period of sickness, or for temporary indisposition only. Two objections have been stated against a provision for sickness during its whole continuance.—1*st*, That it becomes a powerful temptation to indolence and imposture.—2*d*, That the burden is so great that the requisite contribution cannot be supported by the members. To the first objection it has been answered, that the intimate acquaintance of the members of a Friendly Society one with another, provides a guard against any long continued imposture. To the second objection the answer has been given, that the propriety of establishing the provision for the whole period of sickness rests on the sound principle, that the working classes both in sickness and in health ought to be supported from funds received in the form of wages. If a limitation of the period of aid is introduced, it follows, that sickness beyond that limit must, in many cases, remain without relief, or be relieved by a fund provided by charity, public or private. The arrangements which would make the labourer's total recompence consist in wages, or be derived from them, has perhaps a tendency to raise both the rate of wages and the personal respectability of the labourer. And on the other hand, where the total recompence of the labourer is made up of wages and charity jointly, the amount of the latter, according to its extent, seems to have a tendency to lower the former. A Committee of the House of Commons on the Poors' Laws remark, that the number of persons who " can be employed in labour, must depend absolutely on the

amount of the funds which alone are applicable to the maintenance of labour. In whatever way these funds may be applied or expended, the quantity of labour maintained by them in the first instance, would be very nearly the same. The immediate effect of a compulsory application of the whole or part of these funds, is to change the application, not to alter the amount of them. And as the funds which each person can expend in labour are limited, in proportion as the poor rate diminishes these funds, in the same proportion will the wages of labour be reduced, to the immediate and direct prejudice of the labouring classes."

It was on the whole deemed proper to exhibit the computations of sick allowances as for the whole period of sickness from 20 to 70, and also the computations of a life-annuity to members surviving 70; so that the first provision may embrace the total actual sickness and incapacity for labour at and under 70, and the second the presumed incapacity during the remainder of life.

V.—As to sick allowances,—the different descriptions of sickness, to which different allowances are in practice assigned, vary in different societies. Some distinguish *bedfast*, *walking*, and *superannuation* or permanent sickness, assigning distinct allowances to each; while others distinguish the sickness according to its continuance, assigning different allowances for sickness of the 1st, 2d, 3d, quarter, &c., or for other periods recognised by their parti-

cular rules. The proportions which these different descriptions of sickness bear to each other, have not been generally given in the Returns to the Highland Society. Thus it has been necessary to found the computations on one uniform average rate of sick allowance, suggesting at the same time means, by which existing societies, from their own experience, may ascertain the average rate corresponding to their particular rates of allowance; and submitting approximations to enable new societies to reduce the particular rates they propose to adopt for each species or duration of sickness to an average rate, and thence to ascertain from the computations the contribution requisite to defray the particular rates which they mean to adopt.

VI.—The Returns to the Highland Society of sickness among persons above 70 years of age have been considered too limited to be the basis of any computations of *sick allowances*, which can with safety be relied on. It was therefore deemed eligible, as already mentioned, to institute a computation for a constant and uniform provision to members during life after 70, in case Societies should adopt a life annuity as the mode of providing for their members in later life.

VII.—As to a widow's provision.—In the practice of Friendly or Benefit Societies the members make one annual or periodical contribution for all the allowances which the society provides, the contributions

being made by all the members for the same period and at the same rate, and, where there is a widows' fund, without distinction between the married and unmarried members. This combination of different provisions has by some been deemed improper, as preventing a man from insuring what he wants, unless he will pay for what he does not want. On the other hand, it has been said, that simplicity of management requires that all should contribute alike; that, the uniting most intimately the advantage of husband and wife in the contribution, is desirable, lest, on a temporary pressure, the interest of the wife should be disregarded, and the contribution to the widows' fund withdrawn; that among the labouring classes there are few bachelors; and widowers have no cause to complain, since to them during married life, there was insured, at a lower rate of premium, a provision for a widow, on condition of continuing their contribution, though the marriage should be dissolved by the wife's predecease. The difficulty of exhibiting for the guidance of societies in general, a correct general standard for widows' schemes was admitted; but it was suggested, that a Table of this nature would be highly useful, as Friendly Societies, besides a guide, require also a warning that a widows' provision is not the light burden supposed, or one which may be added to the scheme, without requiring an additional contribution,—an error which is considered to be one great cause of the miscarriage of their schemes.

A considerable proportion of the societies provide

an annuity to widows; and it was resolved to exhibit a widows' scheme, since it is desirable to adapt the report to Friendly Societies, as they are found actually existing, leaving it to future societies to adopt such a provision or not, and either as a separate matter, or in combination with the other allowances, as they may deem proper.

VIII.—Upon considering different mortality tables, and conferring with eminent calculators, it was resolved to found the computations upon a medium rate of mortality, derived from the Northampton, Carlisle and Swedish tables.

Among other communications with which the Committee were favoured on this subject, they are indebted to Dr Hamilton of Aberdeen for the following remarks:

" The choice of proper tables for ascertaining the rate of mortality, is a point of the greatest importance. I have not seen Mr Milne's Treatise on Annuities, containing the Carlisle Tables, but observe, that they give the probabilities of life higher than any tables I am acquainted with. The Swedish tables given by Dr Price are also high, and give an intermediate result between the Northampton and the Carlisle Tables. Reducing them all to the basis of 10,000 persons alive at 20, the comparison stands as under.

	Northampton Tables.		Swedish Tables *.		Carlisle Tables.	
Age.	Alive.	Die yearly.	Alive.	Die yearly.	Alive.	Die yearly.
20	10,000	140	10,000	82	10,000	71
30	8,546	146	9,112	103	9,259	94
40	7,086	148	8,059	114	8,328	108
50	5,570	158	6,751	149	7,216	97
60	3,972	160	5,143	189	5,976	200
70	2,400	156	3,070	223	3,939	203
80	913	123	979	158	1,563	190
90	90	23	82	82	232	61

" I should think the calculations should not proceed upon one set of tables only, but upon the medium of several esteemed the best. Perhaps the three above mentioned are as good as any we are at present in possession of.

" I consider it, however, as a *desideratum* to obtain tables founded upon more recent observations than those which we at present use, which (with the exception of the Carlisle one) are founded upon bills of mortality kept long ago. The Northampton Tables are founded upon those from 1735 to 1780. The Swedish ones upon those from 1755 to 1776. Now, it is generally believed, that there has been a sensible increase in the duration of human life, in this and other civilized countries, within the last half century, which may be accounted for, from more cleanly habits, the better treatment of diseases even

* The Swedish Table adopted in the subjoined computations is more recent than the table here referred to.

among the poor, the practice of vaccination, &c. The belief of this is so prevalent, that some of the insurance offices have altered their terms, and the Carlisle Tables seem to confirm the opinion. The effect of an increase of longevity is to increase the value of an annuity for life; to lower the terms upon which insurance of life may be effected; to ameliorate the terms for annuities to widows; but it increases the demands upon Friendly Societies, for the relief of sickness and old age. The number of weeks of sickness at an average, for every age, is now ascertained by the returns to the Highland Society from recent facts, but the number of persons who will make these demands, (if the Northampton or other old tables be used), will be determined by facts as they stood half a century ago, and would give the amount too small for the present time; and it might be expected that this additional demand, arising from a greater number of survivors at different periods, would be compensated by the higher value of the annual contributions, but it appears that it is not fully so, even as to the allowances granted in sickness; for the requisite contribution,

By the Northampton Tables, allowing 3 per cent. interest, is * - -	L. 1	1	$4\frac{1}{4}$
By the Carlisle Tables, -	1	3	$8\frac{3}{1}$

and a similar superiority when 4 per cent. is allowed.

* The rate of sickness on which this was calculated, was varied somewhat by additional returns afterwards received, and is different from that used in the Tables.

"But the difference is much greater in the allowance for superannuation, being,

By the Northampton Tables,	L. 1	0	$11\frac{3}{4}$
By the Carlisle Tables,	1	11	$7\frac{3}{4}$

owing to a greater number reaching the age at which the superannuated allowance commences, and its longer continuance after its commencement.

"Although the possession of more tables, founded upon recent observations, is to be desired, we must, in any present scheme, make the best of those we have. The foregoing observations, however, show how necessary it is in Friendly Societies to incline to the safe side. This ought to be done, even independent of the consideration of increased longevity, as it is much easier to correct an error of deficient than of excessive allowance, and as the managers of such Societies are generally more inclined to go into the latter extreme than the former."

If it should be considered that, in the subjoined computations, the probability of life is taken at a high rate, it is to be remembered that the Members of Friendly Societies constitute a higher order of the labouring classes. Their adoption of this mode of providing independently for their own wants, betokens prudent foresight and elevation of mind; and they are not admissible unless of sound bodily constitution. They are selected lives, and may perhaps be expected to exhibit a degree of longevity somewhat greater, and a degree

of sickness somewhat less, than would be derived from an average of the people at large.

IX.—As to the rate of interest to be adopted in the computations, whether 3 or 4 per cent., much diversity of opinion was found to exist among the most intelligent persons consulted, according as they viewed the probabilities of a rise or further decline in the rate of interest, or considered the fall which has lately taken place as likely to be permanent, or only temporary. The rate of 4 per cent. has been adopted.

The Friendly Societies of England and Ireland, through the medium of the Savings Banks, have, by statute 37th Geo. III. cap. 130. § 6., the privilege of vesting their funds on Government debentures, at an interest of three-pence per day, about 4½ per cent. per annum, and are entitled to receive the principal at any time upon five days' notice. A similar privilege is not enjoyed by the Friendly Societies of Scotland; the framers of the Savings Banks bill for this part of the kingdom not deeming such a provision necessary at the time, from the advantageous rate of interest allowed by the Scottish Banks.

Tables calculated from the Returns made to the Highland Society.

Friendly Societies do not all provide for the same objects, nor do they establish separate contri-

butions for the different allowances which they provide; but, in constructing Tables for general use, it was deemed advisable to show *separately* the rate of annual contributions corresponding to *each* allowance; so that Societies, whether providing allowances, one or more, of different descriptions, may be enabled to avail themselves of the computations. Thus it was considered advisable to shew what an annual contribution of L. 1, continued during life, from 21 to 70 (supposing that contribution paid for *each* description of allowance provided) will afford,

1. Of weekly sick-allowance, from 21 to 70.
2. Of life-annuity, during future life, to each member surviving 70.
3. Of endowment to be paid at the death of each member, for funeral expences, or any other purpose.
4. Of annuity to the widow of each member.

When informed what the contribution of L. 1 will purchase, societies, according as they embrace one or more of these objects, or establish higher or lower contributions, can proportion their contributions to the allowances to be provided. Four schemes, viz. one for each kind of allowance above noted, are afterwards exhibited.

The preliminary points being fixed, Mr John Lyon, Governor of George Watson's Hospital, who had previously digested the Returns made to the Highland Society, had the goodness to prepare certain general computations, applicable to Friendly Socie-

ty schemes. These were submitted to the consideration of some gentlemen of the highest eminence as calculators, and having received their approbation, various Tables have since been prepared by Mr Lyon for the use of Friendly Societies, with explanatory remarks as to their construction, uses, and modes of application.

General View of the Tables.

In order to construct the tables necessary for applying the laws by which mortality and sickness are found to be governed to the pecuniary concerns of Friendly Societies, it has been deemed the simplest course to form a set of tables adapted to a *supposed* society, which commences with 1005 persons all in the beginning of the 21st year of their age, who admit no new members, but die off according to the ordinary course of nature. From the results obtained by means of the tables constructed upon this supposition, other tables have been formed for regulating the affairs of Benefit Societies in general.

The supposed Society, according to the laws of mortality, will consist, in the *middle* of the first year of its establishment, of 1000 members, since of the 1005 members, five will die during the first half year. The first year's contributions, and the first year's allowances, are both considered payable in the middle of the first year of the institution, and so on yearly thereafter during its whole continuance.

In *four* Preliminary Tables there is separately exhibited,

1. The numbers of the supposed Society who may be expected to be *living* each year, and to *die* each year, till all are dead, as deduced from the Mortality Tables already mentioned. It is found that 313 members survive the 70th year of age, and that all die off in or before the 95th year of age.
2. The number of widows of members in life every year, derived from 1000 marriages between persons in the 21st year of their age.
3. The sickness experienced by *each individual* on an average for each year from the 21st to the 70th year of age inclusive, as deduced from the Returns to the Highland Society.
4. The number of weeks' sickness to be expected each year successively from 21 to 70 among the *whole* members of the supposed Society, which is just the quantity of sickness to the individual multiplied by the number of members of the Society living at the time, according to the Table of Mortality.

Materials of Computation thence afforded.

These particulars give the number of contributions annually, and the number of allowances of each description required to be provided annually, during the continuance of each of the schemes. Assuming any rate, both for contributions and allowances, and holding them as payable in the middle of each year,

the amount of each, accumulated with interest to the termination of the scheme, may be ascertained; the results compared, and the contributions and allowances so proportioned, as to equal each other at the conclusion of each scheme.

The number of members living at every age successively, according to the rate of mortality until 70, forms the number of persons contributing each year to the funds of the society.

The average number of weeks' sickness at every age successively, multiplied by the number of persons contributing, forms the number of weekly payments required for sickness during the year, at whatever rate they may be established.

The number of deaths annually denotes the number of payments for funerals; while the number of members surviving 70, and in life annually, and the number of widows annually alive, till all be dead, denote the number of annual payments of annuities, under the respective schemes, at whatever rate these may be fixed. Thus the materials are afforded, whatever provision may be made on these several accounts, to compute the total amount at any period allotted for the termination of the scheme, and to adjust the rates in just proportion to any given annual contribution.

The Four Schemes.

It is assumed, as already mentioned, that each member, during life, from commencing his 21st, to concluding his 70th year of age, pays a contribution

of L. 1 annually, and after 70 the contribution is held to cease,—And it is found,

1. That this annual contribution will afford a weekly allowance for each week of sickness, from 21 to 70, of L. 1 : 0 : 7;—the weekly sick allowance thus somewhat exceeding the annual contribution.
2. That a like annual contribution will provide to a surviving member, during future life after his 70th year, a life-annuity of L. 58 : 0 : 2½ Sterling,—being a little more than 58 times the amount of the annual contribution.
3. That a like annual contribution will provide, at the death of each member, an endowment for funeral charges, or any other purpose, of L. 59 : 19 : 2,—being nearly 60 times the amount of the annual contribution ; and,
4. That a like annual contribution will provide to each widow of a member a life-annuity of L. 5 : 12 : 6½ Sterling,—being a little more than 5½ times the amount of the annual contribution.

The provision for these four several purposes is held to be the object of *four* separate schemes: 1*st*, Sickness Scheme;—2*d*, Members' Annuity Scheme;—3*d*, Scheme for Funeral Expences, &c.; —4*th*, Widows' Annuity Scheme. These schemes are supposed to be established by *four* separate Societies, constituted as above described, to each of which schemes the same amount of annual contribution, and for the same period of time, is supposed to be made.

It is requisite, with a view to particular objects, to contemplate the contribution under *three* different aspects; *1st*, As paid and accumulated annually; *2d*, As superseded by a single payment made at the commencement of the scheme, in lieu of all annual contribution; *3d*, As superseded, at any later age, between 20 and 70, by a single payment then made, in lieu of all contribution, after such later age. Accordingly, in the Tables of Contribution, (Scheme I. Tables I, II, III.) there is exhibited,

1st, The total amount of the contribution, accumulated at 4 per cent. interest (Scheme I. Table I.), till the conclusion of the schemes, and also its annual amount progressively at every period.

2d, The sum which paid down at the commencement, by the members of any of the four supposed societies, will supersede all future contribution. This is found (Scheme I. Table II.) to be L. 18,117.271 decimals, or L. 18,117 : 5 : 5 for the society in all, or L. 18 : 2 : 4 Sterling, paid by *each* member of the society, at the middle of the *first* year of its establishment.

3d, The sum which, paid down at *any age*, (Scheme I. Table III.) from 20 to 70, will supersede all future contribution.

These several circumstances, with regard to the contribution, are exhibited in *three* Tables, which are *common to all the schemes*, the sum of contribution being in all the same, viz. L. 1 annually by each member in fee; continued during the same periods of time, viz. from the beginning of

the 21st to the end of the 70th year, if the member lives so long; and thus, at the longest, continuing payable for 50 years. The schemes differ, however, in the period of their duration, the Sickness Scheme terminating in 50 years, when the members have completed the 70th year of their age; while the other schemes continue till all the members and their widows will, according to the Mortality Table, be dead, that is, for 25 years longer, or 75 years in all. The Sickness Scheme concluding in 50 years, the contribution of its members accumulated, with interest, for that period, amounts in all to L. 128,753 .706 decimals, or L. 128,753, 14s. Sterling. In the other schemes, the like contribution, continued for the same period of years, but accumulated at interest for 25 years longer, amounts to the sum of L. 343,236.307 decimals, or L. 343,236, 6s. Sterling, (Scheme I. Table II).

Tables peculiar to each Scheme.

The Contribution Tables, No. I, II, III, given in Scheme I., are held as repeated in each of the other Schemes, and form a part of them, though, in place of being repeated, they are merely referred to in Schemes II, III, and IV. As to the Contribution Table, No. II, it may be observed, that although placed in Scheme I. that part of it which exhibits the accumulation, from 71 years of age, is not applicable to Scheme I. but solely to the Schemes II, III, and IV.

The three Tables *peculiar* to each of the four Schemes, are thus the Tables IV, V, and VI, of each.

These several classes of Tables exhibit the circumstances of contribution and distribution, &c. according to their bearing on each particular scheme.

Thus, Table IV. of each Scheme shews the *accumulated amount* annually, from the commencement to the conclusion of the scheme, of the whole *distributions* falling to be made under it, according to the number of payments denoted by the Preliminary Tables as becoming exigible, and according to the particular rates of payment, under each scheme, as already noticed, viz.

1. *Sickness Scheme.*—For each week of sickness, - -	L. 1	0	7
2. *Members' Annuity Scheme.*—To each member, for each year he survives 70, a life-annuity of	58	0	2½
3. *Funeral Scheme.*—At each member's death, at whatever age, an endowment for funerals, or other purposes, of - -	59	19	2
4. *Widows' Scheme.*—To each widow a life annuity of - -	5	12	6½

The *fifth* Table of each Scheme *compares* the *contribution* and *distribution* annually, and ascertains the amount of their *difference*, which is the Society's stock. At the conclusion the accumulated amount of the contributions agrees with the accumulated amount of the distributions. The contribution and

distribution, in the Sickness Scheme, both amount to L. 128,753.706, or L. 128,753, 14s., and so balance each other. In the other schemes, when the contribution is improved at interest, for 25 years more, it amounts to L. 343,236.307, or L. 343,236, 6s., and is balanced by the distributions, which, in each of these schemes, amounts to the like sum of L. 343,236, 6s.*

The *sixth* Table of each Scheme shews,

1. The *value* to the Society, at any age, during the continuance of the scheme, of the *individual stock* of each member arising from his past contributions.

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* The contribution and distribution, both assumed as payable in the middle of the year, are found in columns 6. of the Tables I. and IV. of each Scheme, which shew the contributions and distributions opposite *the particular year* for which they are made. But in Table V. of each scheme, in the columns for *comparison*, viz. columns 4. and 5., the contribution and distribution of the first year, with a year's interest on each, are stated opposite year *second* of the Scheme, when the year's interest has arisen, and the comparison is then made, and so on throughout; and thus the contribution and distribution, in the concluding years, *i. e.* in the 50th and 75th year of the Scheme, appear, (were Table V. only adverted to,) as not made till the 51st and 76th year.—The interest on both contributions and distributions are carried down for half a year beyond the termination of each scheme, making, from the commencement of contribution and distribution, in the *middle* of the first year of the Scheme, an accumulation of 50 or 75 whole years on each Scheme. The accumulation of the interest might have been stopt, on each Scheme, half a year earlier, but this has no effect on the Schemes.

2. The *value*, at any age, of the *future contributions* of each member.
3. The *value*, at any age, of *future distributions*, or the single payment, at any age, equivalent thereto.
4. The annual contributions, commencing at any given age, and continued till 70, corresponding to the future distributions after the given age.
5. The allowances or distributions under each Scheme, corresponding to an annual contribution of L. 1, commencing at any age, and continued till the age of 70.

Object in ascertaining some of these particulars.

Some observations may be made regarding the object of ascertaining, as to each Scheme, the particulars referred to in describing the class of Tables last noticed.

1*st*, The *individual stock* of members at *each* particular age.—This is the amount of the money which members of that age, on an average, have deposited with the Society, from their *past* contributions, beyond the average amount of the sums drawn out by them as allowances, together with progressive interest on the balances from time to time. This, at every age, represents the sum which an entrant of that age (except in Scheme IV. for reasons to be afterwards stated) should pay down, beyond his annual contribution, as an equalising payment on entering the Society at a later age than his fellow

members. For this is the sum which each of the other members, entering earlier into the Society, and continuing in it until his age, has now at his credit with the Society, to aid the future contributions in discharging future allowances; and it is also the sum which, together with the future contributions of such member, is just sufficient for discharging all his expected allowances.

2dly, The present value of all the *future contributions* of the existing members.—This is the value of the Society's funds in expectation; or, in other words, of the debts *due to* the Society by its members; and is necessary to be known, wherever we wish to ascertain the state of a society's affairs.

3dly, The present value of all the *future allowances* to be made to members.—Whatever that present value may be, it represents the *debts* due by the Society; and, as the solvency of the Society depends upon its ability to pay its debts, it is necessary to know the total amount of these debts. To ascertain this, in a Friendly Society, at any period, we must find the *value of all the future allowances*, that will become payable to the members, according to the existing state of the Society at the time.

Balance of a Friendly Society's Affairs.

Thus, to ascertain the ability of the supposed society to fulfil its engagements to sick members in the 40th year of the scheme, when it has 528 mem-

bers of 60 years of age, we make the following comparison:

FUNDS.

	decim.
Its Funds in possession, by Table V. of Sickness Scheme, Column 6. amount to	L. 15,405.753
The value of the *future contributions* of each member of this age, by Table VI. of Sickness Scheme, Column 4. is L. 7.6914 decimals, which, for 528 members, is	4,061.059
Total funds in possession and in expectancy,	L. 19,466.812

DEBTS.

The value of the *future allowances* to each member, by Table VI., column 5., is L. 36.8689 decimals, which, for 528 members, is - -	L. 19,466.779	
Add fractional loss of decimals in the division, (value about 8d.), - - -	.033	
		L. 19,466.812

Thus, the Funds and Debts of the society are equal, each amounting to L. 19,466 : 16 : 3 Sterling.

This may give some general idea of what is meant by balancing the affairs of Friendly Societies,—a measure not hitherto familiar to their members.

But in balancing the affairs of an actual Society, although the general nature of the operation be the

same, there will be certain differences. 1*st*, Its members will not be all of the same age. In place of ascertaining at once the values of the contributions and future allowances of the whole of the members, as is done in the above statement, it will be necessary to class the members according to age, and to ascertain from the Tables separately, according to the medium age of the class, the values for the whole members of each class, according to their numbers. 2*dly*, The contributions and allowances in the Society, may not be the same as those assumed in the Tables; and the total values ascertained from the Tables must therefore be raised or lowered, in proportion as the contributions and distributions of the Society differ from those in the Tables. If the contributions of the Society are only one-half of those in the Tables, their values will be only one-half; and the same holds as to the distributions. Thus, the values ascertained from the Tables, become a mean for stating a question of Proportion, according to the Rule of Three, for ascertaining the values of the future contributions and distributions of any Society.

Rise and Decline of a Society's Funds.

The rise and subsequent decline of the funds of a Friendly Society, may be illustrated by showing the progress of the Sickness Scheme at different periods, as follows:

Year of Society.	Age of Members.	Amount of Contribution.	Amount of Distribution.	Society Stock.	Individual Stock.
10	30	£10,594·580	£6,402·455	£4,192·125	£4·6067
20	40	26,490·949	16,905·909	9,585·040	11·9813
30	50	48,565·427	34,085·767	14,479·660	21·4513
40	60	79,574·896	64,169·143	15,405·753	29·1775
45	65	99,611·847	86,217·701	13,394·146	30·2351
46	66	104,057·041	91,753·836	12,303·205	29·0856
47	67	108,659·243	97,870·173	10,789·070	26·7719
48	68	113,424·733	104,633·398	8,791·335	23·0743
49	69	118,357·962	112,042·080	6,315·882	17·5930
50	70	123,465·640	120,099·226	3,366·414	10·0191
	71	128,753·706	128,753·706	Nothing.	Nothing.

Thus, the distribution and contribution at the end of the scheme, when all the members have died out, are equal; and, on taking the differences of these, at different periods, which are exhibited in the Column titled "*Society Stock*," the stock of the Society is seen increasing for many years, and then rapidly diminishing.

The progress of no two Societies can ever be quite alike; nor is this statement offered as exhibiting the precise course of the progress of any Society. Still it shews, in some measure, the general course of all Societies, and illustrates the cause of that illusion which makes members too often infer prosperity while their affairs are going rapidly to decline; an illusion practically injurious, and which it is of importance to dispel.

Had the supposed society set out with an insufficient contribution, suppose 18s. in place of L. 1, annually, still its capital would have increased rapidly for many years. If, during each succeeding

period of years, it had been recruited by young members, their contributions in early life exceeding their allowances, the accumulation of capital would have been accelerated. In the long run, however, all the contributions of the original members being inadequate to their whole allowances, an encroachment to supply the deficiency would be made on the funds of the class who entered after them; and thus the matter would proceed, all the deficiencies of preceding classes in point of contribution, as well as the interest such contribution should have produced, being a loss to the fund, and falling on the classes succeeding them, until the Society is bereft of its capital, and falls to ruin. Still, a long period of years might pass, before the growing injury was known, unless periodical balances were instituted of the Society's affairs; and it is to enable Societies to make such periodical balances, that some of the particulars already adverted to have been exhibited. Articles 8th and 44th, and Problem VI., are recommended to the particular consideration of Societies who wish to make a correct balance of their affairs.

Circumstances of Difference in the Several Schemes.

The Schemes for Sickness, Old Age, and Funerals, depend on contingencies affecting a single life: the Sickness Scheme, on the combined operation of the laws of Mortality and Sickness; the two others, on the law of Mortality alone. The Fourth, or Widows' Scheme, on the other hand, depends on the duration of joint lives. There is no claim if the

wife die before the husband; and, if she survive, the value of her claim depends on her age at the death of the husband.

The method of computation adopted, affords the means of exhibiting in the five first Tables of each Scheme, in a way which, it is thought, many members of Friendly Societies will be able to follow, the steps by which are obtained the results exhibited in the Sixth Table of each Scheme; and this may, it is hoped, lead to confidence in the results. But these five first Tables of each Scheme, though all constructed by the same method, do not afford results of the same general application.

In Tables VI. of the Sickness, Old Age, and Funeral Schemes, results are exhibited which are applicable very generally to all Societies of a like nature, providing for the same objects; and this, too, at *whatever age* such Societies admit members. But this does not hold as to the Widows' Scheme. The results deducible from the five first Tables of that Scheme, and exhibited in the sixth Table, are only applicable to *one* case; that of a Society where all the members enter at 21 years of age.

In tracing the progress of the four Schemes, a difference will be observed. The burdens arising on the three first Schemes are fully provided for within the year in which they arise, either by the contributions of the year, or from previous contributions. A surplus stock is found to arise to each member, after defraying the allowances for the year, and this continues throughout till the conclusion of

these Schemes, when the whole is exhausted. Thus, a new entrant at 30, or any later age than 21, enters on equal terms with the other members, by placing with the Society his proportional share of stock, and paying in future the like contribution with the others.

In the Widows' Scheme, on the other hand, during the *first* year, certain widows come upon the scheme. Besides the annuity for the year, which is paid from the annual contribution, there has arisen in favour of these parties an annual claim for the whole of future life, of which no part should be borne by a future entrant. The contribution to the Scheme exceeds, it is true, the widows' pensions demandable within the year; but the whole contribution of the year is not fully adequate to purchase annuities for future life, for the widows who, during the first year, have come upon the Scheme. Thus, though this Scheme is correct for a Society all whose members enter at 21, it does not shew the terms on which future members should be admitted at later ages, and, therefore, does not afford results of general application.

To supply this defect, two Auxiliary Tables, VII. and VIII., are added to Scheme IV., exhibiting the entry-money and contribution, &c. at later ages than 21. The application and use of these Tables in balancing a Widows' Scheme, is exhibited in Article 40th, and Problem 6th; and an approximation is suggested for the variations required, where annuities are provided to widows of

future marriages, as is general with Friendly Societies who have widows' schemes.

It was, upon the whole, deemed eligible, however, to exhibit Scheme IV., shewing the progress of a widows' scheme, as for a Society at 21. Any Society limiting the admission to one particular age, may balance its affairs by a similar process. A Society admitting members of 30, or any other age, and forming a widows' table, applicable to that age, might then proceed according to the mode followed in Tables IV. V. and VI. of this Scheme. Another reason had much influence. The processes used in constructing the auxiliary Tables VII. and VIII. of Scheme IV. do not admit, as it is thought, of being explained, so as to be followed by persons not familiar, in some degree, with the higher branches of arithmetic; but an opportunity being afforded them of examining the operations by which the results are obtained of a widows' scheme for a society of members at 21 years of age, it is hoped the members of Friendly Societies may be induced to place reliance on the results of the auxiliary Tables, although the processes by which they have been obtained are not exhibited; and besides, to exhibit the operations at each age, as is done with regard to the supposed society of 21, would lead to an inconvenient multiplicity of tables.

Some possible objections considered.

It has been usual with calculators to consider societies in the aggregate, as bodies, and from the

rules as to the age of admission and rates of allowance, to compute the *maximum* pressure upon the scheme, and fix the contributions accordingly. Each society is thus viewed in its particular circumstances; but, as societies rarely coincide in all points, rules of general application cannot thus be obtained.

From a desire to obtain rules more generally applicable, a course somewhat different has been adopted. The Committee have directed their attention to Friendly Societies in that point of view in which they all agree, as composed of individuals of known ages. It has been their object to ascertain the proportion which the contribution of an individual, according to the age at which he enters, ought to bear to the allowances provided by such societies, and they have exhibited the variations of this proportion, according as the age advances. Societies, when aware of the difference arising from the age of entrants, will naturally consider how equality among their members may be reconciled with the simplicity desirable in the management of their affairs.

It is important to divest the subject of every thing unessential to its correct illustration. The intricacy arising from the admission of new members has been avoided, by assuming that the supposed society, whose progress is traced, does not admit any. The value of the contribution of a member, and of the burden which he creates from each particular age, is thus distinctly and separately shewn, as to the Sickness, Old Age, and Funeral

Schemes: it is traced with equal accuracy, exhibited with more simplicity, and the knowledge, when attained, is of general application.

It may seem strange, that the Tables should exhibit the state of a society which never does nor can be expected to exist, viz. that of a society which begins with a certain number of members, all of the same age, and which admits no new members. But it is to be observed, and to be carefully attended to, that the Tables exhibiting the progress of such a society, are not intended to be held out as shewing the progress of any *actual* society, but merely as exhibiting *the steps* by which the results contained in the Tables, No. VI. of the Schemes, have been obtained. It is from these Tables, and these alone, in connection with the auxiliary Tables VII. and VIII. of Scheme IV., that data are to be sought for regulating the contributions and distributions of Benefit Societies, and for investigating the states of their affairs.

Many persons will not acquiesce in the results without full examination, and the details will facilitate this investigation. Others will acquiesce more readily in the results, that the process by which they are acquired is presented for consideration, even although they should not take the trouble to examine it. Those, on the other hand, who consider that the results only should have been exhibited, will find these apart in Tables VI. of each Scheme, in the Auxiliary Tables VII. and VIII. of Scheme IV, and in the Practical Tables; and may pass over all the others.

Societies desirous to construct schemes founded on the rate of sickness ascertained by their own experience, will, by the full exhibition of the necessary steps, have their course facilitated.

The Committee have not sought the briefest mode of exhibiting the subject, since comparatively few could have followed it. Their object has been to exhibit the matter in the way in which it is likely to be understood, with the lowest portion of arithmetical knowledge which the subject admits, so as to render it more generally accessible. And the plan which has been adopted, although liable, like every other, to some objection, was, after full consideration, deemed best adapted to attain that end.

Practical Tables.

The regulations of Friendly Societies requiring the confirmation of the Justices of the Peace, the Justices are often called upon to consider the contributions proposed by persons desirous to institute a new society, and the allowances which these contributions are meant to defray. To facilitate this examination, certain tables are given, under the denomination of Practical Tables.

There are four views which may present themselves; 1*st*, A Society may *fix the contribution*, and be desirous to know what allowances it will afford; or, 2*dly*, They may *fix the allowances*, and wish to know what contribution will be adequate to them; or, 3*dly*, They may fix a rate of *entry money*, besides the contribution, and desire to know what

amount of contribution this entry-money will supersede; or, *4thly*, The right to the allowance may be deferred for some period after the commencement of the contribution, and information may be desired as to the effect thence produced on the contributions and allowances. Information on these points will be obtained from the Practical Tables.

First, In order to shew what any contribution, according to the age at which it commences, will afford in the shape of allowance, four tables have been prepared, which are denominated *Practical* Tables, viz. one for Sick Allowance; one for Members' Annuity; one for Payments at Death, or for Funerals, and one for Widows' Annuity. Supposing the age of the entrants given, and that they are of any age from 21 to 45 both inclusive, then opposite to each particular age in the tables will be seen what an annual contribution of L. 1, or 10s.,—5s.,—4s.,—2s. 6d.,—2s.,—or 1s. will severally afford (according to the age at which it commences), as sick allowance, widows' annuity, &c.

Thus, suppose the entrants are 21 years of age, and that they contribute annually,

For Sick allowance, -	L. 0	10	0
Members' annuity after 70, -	0	2	6
Endowment at death of member,	0	2	0
Widows' annuity, - -	0	10	0
In all annually*,	L. 1	4	6

* The Tables being computed, on the supposition that the incidental expences of the society, which may be averaged

This annual contribution of L. 1 : 4 : 6, commencing in the 21st and continuing to the 70th year of age (Practical Tables, I, II, III, IV.), will afford of

Sick-money weekly, till completing the 70th year, - - -	L.	0	10	3½
Members' annuity after 70, -		7	5	0¼
Endowment for funeral, -		5	19	11
Widows' annuity, - -		2	16	3¼

Supposing the contribution the same, but the entrants to be of 40 years of age, the allowances to be afforded will be less. To them the corresponding allowances are,

Weekly sick money, -	L.	0	5	7¾
Members' annuity, - -		2	4	4½
Funeral money, - -		3	9	0¾
Widows' annuity, - -		2	5	0¼

Secondly, The Practical Tables already adverted to, assume a *contribution*, as agreed on, and shew what allowance it will purchase. A second set of Tables, Nos. V, VI, VII, and VIII, assume an *allowance*, as agreed on, and shew what contribution it will require. This is shewn for members entering at any age from 20 to 45, as to the following allowances :

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at 10 per cent., shall be *separately* defrayed, a further sum of about 2s. 6d. annually would be required on this account, in the case supposed, which would make the total annual contribution L. 1, 7s.

1. A weekly sick allowance (Practical Table, No. V.), of - -	L. 0	5	0
2. An annuity for old age (Table IV.), of - - -	5	0	0
3. An allowance for the funeral of a member (Table VII.), of -	5	0	0
4. An allowance for a widow's annuity (Table VIII.), of - -	5	0	0

Whatever rate of allowances the society may choose to adopt, the contribution required may easily be deduced from these Tables.

Thirdly, It is important for societies to know, how far a sum paid down as *entry-money* will supersede future contribution. The Practical Table No. IX., will enable societies to ascertain this point. Assuming an entry-money of L. 1 to be established, this Table shews what amount of annual contribution will be superseded by that entry-money, according as the age of the entrant is from 20 to 45, this last age being assumed as the extreme limit of entry. Whatever rate of entry-money societies may establish, they may, with facility, deduce from this Table what amount of annual contribution may thereby be superseded.

Fourthly, It is a common practice with Friendly Societies, probably as a guard against the entrance of members in bad health, to provide, that a member shall not become *free*, or, in other words, shall

have no right to any allowance, until he has contributed for three years. The effect of such an arrangement, in diminishing the contribution required, or, if the standard contribution is continued, its effect in enlarging the amount of distribution to be afforded, is exhibited in Practical Tables X, XI, XII, and XIII.

Entrants of different ages, how placed on an equal footing.

It has been clearly shewn, that, in order to place the members on a just footing, so as each may bear his due share of the burden, equal annual contribution in every case will not suffice. It seems necessary, either,

1. That all shall enter at the same age; or,

2. That the difference of age shall be compensated in one way or other: And there are three ways in which later entrance may be compensated;

   1st, By the party paying an equalising fine at entry; or,

   2d, By paying a higher rate of annual contribution, according to his age; or,

   3d, By receiving a lower rate of allowance.

The entry-money, increased contribution, or diminished distribution, which will be equivalent, at every period of life, to compensate inequality of age, are exhibited with reference to each scheme; in Table VI. of the Schemes I, II, III, and in Table VIII. of Scheme IV, already mentioned.

These being calculated as for an annual contribution of L. 1, give a mean which will enable any society to ascertain what is required, in its own case, in order to place entrants, of any age, on a footing at once fair to them, and to the society at large.

The Committee are aware, that the Practical Tables do not exhibit all the varieties which may be required in practice; but they have purposely abstained from extending them farther, deeming it, upon the whole, better to leave it to Friendly Societies to obtain any other results they may desire, by deduction from the Tables which are given, than to attempt to exhibit the results in all the varieties deducible from the Tables of the Schemes. If Friendly Societies shall be convinced that their schemes admit of calculation, they will either make themselves intimately conversant with the subject, so as to compute what they require, or will resort to the aid of others more familiar with computation.

Observations on the Use of the Tables.

With reference to the contributions and allowances, it will be proper for any society using the Tables, to observe,

1. That some contribution for incidental expences will be required, over and above the contribution specified in the Tables. In practice, this charge appears to vary from 7½ to 12½ per cent. *Ten* per cent. *at least should, in almost every case, be added to the contribution specified in the Tables, as an average allowance for such expences.*

2. The Tables exhibit the allowances, with pence and fractions, precisely as derived from the computations; but societies will naturally fix their allowances in *even* sums; and it will be expedient to diminish the allowances specified in the Tables, by throwing off the odd pence and fractions, rather than to attain an even sum by an increase of the allowance.

The Tables afford a Standard for Comparison.

While prudence dictates the propriety, in all important transactions, of calculating beforehand the probable course of affairs, according to the best means which are possessed, still, in all human affairs, there are occasional circumstances which defeat every previous calculation. Friendly Society Schemes, however accurately constructed, like all other calculations founded on probabilities, must be exposed to such casualties. The small number of members of which many societies consist, admitting the members to be known to one another, contributes to a correct superintendence of the affairs; but has this disadvantage, that average computations, derived from a great number of such societies, although correct as to the whole, will rarely be found to agree precisely with the experience of any particular society. Such computations, however, are standards to be appealed to, in order to ascertain how far the current of affairs, creating unlooked for burdens, may have drawn them from their course.

Recapitulation.

To enable Friendly Societies to calculate the proportion which, upon an average, their contributions ought to bear to their allowances, reference being always had to the age of admission,—to enable them to review their condition,—to ascertain how far their means are equal to their engagements,—to shew the proper increase of contribution to meet a deficiency of funds,—or the increased distribution which a surplus can afford,—so as to enable them to accommodate their arrangements to their circumstances,—are the objects sought to be accomplished by the subjoined Tables and Rules. The improvement of Friendly Society schemes must, it is conceived, mainly depend, as already noticed, on a diffusion among their own members of some knowledge of their principles. This is what has been here attempted. The Committee will be gratified if their labours shall, in any degree, contribute to establish, on a firmer basis, institutions which they deem at once laudable in themselves and nationally beneficial. They may have erred in the means, or they may have failed in the attempt; but it is with satisfaction they reflect, that even their failure or their errors will not be useless, should they have the effect of engaging others better qualified to undertake the task.

Miscalculation, not the Mismanagement, of Friendly Societies, the cause of their Failure.

When the immense number of such societies is considered, the general uprightness of their management appears, so far as has been observed, to be highly exemplary. The collecting and duly investing the funds is a duty in general very prudently executed; and great labour is gratuitously undertaken by the members, in visiting their sick brethren, and conveying to them the allowances for their relief. Miscalculation, not mismanagement, appears to have been the cause of their miscarriage. It has not been made imperative on Justices of the Peace in Scotland, as it has been in England, to require the report of two accountants on the correctness of the calculations on which new societies propose to found their schemes; but it might conduce to the wellbeing of such institutions, were the Justices of the Peace of Scotland to require some evidence on this subject in future, before sanctioning the regulations. This is the most important part of the rules; but hitherto, perhaps, it is not the part to which, in the practice of Justices of the Peace, their principal attention has been directed. In apportioning the contributions and allowances, the leading point is the age at entering the society; and this, in practice, as already noticed, sometimes differs in the outset from what it is in the sequel. It may therefore be expedient to require a list of the names and ages of the constituent

members of any new society, to be exhibited when regulations are sought to be confirmed, that both the age of the original constituent members, and the rules as to the age of future entrants, may be under view in considering the contributions and allowances, which they propose to establish.

Some General Laws, &c. suggested.

It has not been the object of the Committee to point out any particular course to Friendly Societies. Their endeavour has been, to enable the members to see their way beforehand, in any scheme which they may wish to adopt.

Without departing from the limits within which the Committee proposed to confine themselves, they may be allowed to notice, that there are *two* rules which, perhaps, it would be right to introduce into the regulations of all societies: 1*st*, That all disputes between the society and any of its members, shall be referred to arbitration. 2*dly*, That no part of the society funds shall, in any case, be lent to a member; and that no member shall be received as surety to the society for a loan.

In the laws of new societies, where allowances are provided for different purposes, as sick allowance, widows' annuity, &c., it might be expedient to state separately the premium or contribution which the society had assumed as equivalent to each. Some advantages would arise from this practice. It would tend to prevent any allowance being established without some equivalent, actual or estimated, being

established to meet it. It would further give the society more distinct means of retrospect, and, in case error had been committed, enable them to trace, on reviewing their own experience, in what particular department the error has arisen. While the several contributions, estimated as equivalents for particular objects, may, for these reasons, be separately notified in the laws, it may still be proper that the whole be combined, for convenience of collection, into one sum of total contribution as at present.

If members, desirous to provide for a widow, were authorised to insure, under Scheme III., a sum beyond the Funeral money, payable at their own death, a widow's provision might be established in a form somewhat simpler than a fixed annuity, and better adapted to such institutions. The sum insured for a Funeral may be held to constitute *a share*, for which a contribution is fixed. A member might be allowed to subscribe for as many shares as he thought fit, contributing just so many fold the fixed funeral contribution, as corresponds to these shares. The sum thus insured at the husband's death, might, as societies deemed best, or as the member might appoint, be paid at once to the widow, to be applied as she thought fit,—or such an annuity might be paid to her as the sum, at her age, would purchase with an insurance office, or such as corresponded to her age according to Col. 2. of Table VII. Scheme IV.: If there was no widow, the sum to go to the children of the member, or otherwise, as he might appoint.

If it were optional to members to insure for such shares as they thought fit, and to drop the insurance at pleasure, the contributions for these should not be combined with the contributions for other purposes.

The effect of deferring the allowances to the members for three years after entry, is exhibited, that Friendly Societies may be quite aware of it; but where a society is to be established, it would be advisable, at the outset, not to found any thing upon such a provision, but, in fixing the contributions and allowances, to be guided by the Practical Tables I. to IX., or such of them as are applicable to the case; for the average rate of sickness on which the calculations are founded, is necessarily lower than the rate in some societies, and higher than that in others. The advantage obtained to the fund from the allowance being deferred, would enable societies, whose actual sickness exceeds the rate on which the computations proceed, to bear their heavier burden, without resorting to the ungracious measure of diminishing the allowances or increasing the contributions. A society, again, whose sickness shall be found, not to exceed or to fall short of the rate on which the computations are formed, could, after this fact was ascertained by their own experience, enlarge their distributions, a measure always gratifying to the contributors. Thus, the deferring the allowance for some time at commencement, as is a common practice, would guarantee the stability of the schemes generally, give confidence in their perma-

nence, and at the same time, in cases where the guarantee was by experience found to be unnecessary, would justify a future enlargement of allowance. It is always to be remembered, that it is easier to correct an error of deficiency than of excess of allowance, and that the latter is the error into which societies are most apt to fall.

Friendly Societies have much of the character of Life Insurance Companies. The latter ascertain periodically the general state of their affairs, estimating the value of their engagements, &c. A similar estimate by Friendly Societies every year, or at least every five years, would be highly expedient. The Life Insurance Companies thus know the present value of the claims that may come against them; and when any of the persons insured are disposed to withdraw, these Companies are in use to purchase up their claims at a rate under the actual value, and this abatement forms part of the profit of the company. Were Friendly Societies once established upon correct principles, and accustomed to ascertain periodically the value of the individual stock of their members, it might deserve consideration whether it would be expedient that the Directors should have a discretionary power to purchase up, under some regulated abatement, the interest of members who are going abroad, or who have become permanently established at such a distance as renders inconvenient the maintenance of their accustomed relations with the society. An arrangement of this kind would obviate a general objection which frequently leads young

men to postpone to a more advanced age their entering into societies. The Committee are informed, that a society, at present about to be established, have consulted a professional accountant of eminence upon their scheme, with the view of introducing a regulation of this nature.

There are some practices already established in particular Friendly Societies, which might, advantageously perhaps, be adopted by all,—for example: To keep a roll of the members' ages and deaths, as practised by the Society of Seamen of Prestonpans; to keep a cash-book with columns for exhibiting the age of sick members, and the description of sickness, as is done by the Society of Carters at Tranent; and, to enter in their records, and print and circulate among the members of the society, a state of the annual transactions, rate of sickness, and deaths of members, as practised by the Deanston Society of Perthshire. This annual state affords *data* from which the periodical estimates of the society's engagements, &c. already recommended, may at any time be formed. Forms for each of these states will be found in the Appendix, No. II.

Similar practices are becoming general in the best regulated societies. Their records may thus come to exhibit at a single view the whole sickness, in its varied descriptions, and the whole deaths, and ages at death of the members, with every desirable degree of accuracy. Were the experience of every Friendly Society duly recorded, it would be found of great advantage to themselves, in enabling them

to review generally the state of their whole affairs. And they would thus, without any trouble to themselves, have it in their power to communicate at any time, should circumstances arise to cause a future inquiry to be instituted, full and accurate information of the mortality and sickness among their members, without again encountering the toilsome task which became necessary, from the state of their own records, in contributing their aid to the present inquiries;—a task which could only have been accomplished by a great and highly meritorious exertion of zeal and industry on the part of their members.

With these observations the Committee shall conclude their Report. The origin of the inquiry, and its results, have been generally explained. The data obtained, will enable calculators in future to proceed, in framing Friendly Society Schemes, on an ascertained rate, in place of a supposed rate, of sickness. A general view of the Tables, prepared under the direction of the Committee, has also been given. The Tables themselves, with Mr Lyon's detailed explanation of the principles of their construction, and Rules and Problems to facilitate their application to the diversities of schemes, are subjoined to this Report.

It will be kept in view, that the Committee have not brought forward any particular scheme for general adoption. Their object has been, to exhibit Tables which may enable societies generally,

whatever scheme they may wish to adopt, to establish their Contributions and Allowances on the foundation of actual experience, and to review their affairs with facility from time to time.

Humbly reported by

CHAS. OLIPHANT, W. S.
Convener of the Committee.

EDINBURGH,
12th *March* 1824.

SUMMARY OF *RESULTS* OF *RETURNS*,

BY

Friendly Societies of Scotland,

For various periods of years from 1750 to 1821, established in the Counties of

AYR, BERWICK, CROMARTY, DUMFRIES, EAST LOTHIAN, EDINBURGH, FORFAR, LANARK, LINLITHGOW, PEEBLES, PERTH, RENFREW, ROSS, ROXBURGH, SELKIRK, AND *STIRLING,*

To the SCHEDULE issued by

The Highland Society of Scotland.

	Number of Free Members,								Number of Weeks of Sickness of Free Members,							
	Under 20 years of age.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70 years of age.	Total.	Under 20 years of age.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70 years of age.	To
‹, 15 Societies,	304	3591	7054	6986	4094	1430	255	23714	107	1718	4239	6067	6470½	8656	5741½	33
, 8 ditto *,	4	1357	3156	2744	1673	720	222	9876		354	1235	2029	2538	2909	2977	12
, 24 ditto,	284	8158	14024	9493	4638	1830	479	38906	116	4738	10628	10235	8910	10783	6900	52
‹, 9 ditto,	35	544	801	598	355	148	85	2566	3	356	556	488	771	765	2360	5
‹, 11 ditto *	20	445	1041	1042	601	253	78	3480	22	277	692	1180	1278	1858	622	5
‹, 12 ditto,	409	9414	10185	4256	1237	167	8	25676	153	6464	7544	5807	3724	651	39	24
‹ 79 Societies,	1056	23509	36261	25119	12598	4518	1127	104218	401	13907	24894	25806	23691½	25622	18642½	132
verage Sickness to an Individual yearly, in Weeks and decimals of a Week,......									·3797	·5916	·6865	1·0273	1·8806	5.6357	16·5417	1·2

Vota.—Nos. *4th* and *5th* are Returns for three years, 1819, 1820, and 1821. * These Returns are corrected according to the Reporters' suppositio

There are only 73 *different* Societies, for 6 are given twice, both for the long and the short period of years.

TABLES,

WITH

OBSERVATIONS

UPON THEIR

CONSTRUCTION AND USE.

I.

INTRODUCTION TO THE TABLES.

1. THE object of the Highland Society of Scotland in requiring the Returns from Friendly Societies, was to obtain correct information of their general constitution, with respect to their contributions and disbursements; and more especially to ascertain the average *quantum* of sickness which an individual undergoes at different ages:—in order to be able to determine, from more accurate data than heretofore possessed, the proportion which the contributions and allowances in such societies should bear to each other; and also to point out a method of investigating the state of their Funds from time to time, by which it might be known whether their affairs were in a prosperous condition or not; in other words, whether their Funds were sufficient to answer all demands likely to be brought against them.

Funds of Friendly Societies.

2. According to the constitution of Friendly Societies, their Funds arise, in general, from a sum of money paid by each member upon his admission, as

entry money; and an annual contribution for life, or at least during health, of a smaller sum paid weekly, monthly, or quarterly.

In many cases, instead of entry-money, and sometimes in addition to it, it is required that members shall have continued to contribute for one or more years, before they shall be admitted to the benefits of the society.

In all Friendly Societies, the time of admission is limited within a certain age of life. This appears to have arisen from societies having formerly required the same entry-money and annual contribution from all members, at whatever age they were admitted. In most societies this is the case still; but in several of those more recently established, although the age is limited, the entry-money increases with the age of the entrant; the annual contribution, however, remaining the same for all.

In many societies, a particular contribution is raised when required, for a specific purpose; such as for defraying the expenses of the Funerals of members, or of their wives.

Fines for misconduct in members, frequently afford a small addition to the revenue of societies; and benefit sometimes accrues from the retirement or expulsion of members, as the contributions of early life leave a surplus after defraying the sick allowances, while the claims for allowances must in general increase with age.

Disbursements.

3. The disbursements of Friendly Societies, generally consist in allowances for sickness or inability to work, paid weekly; and allowances for the funerals of members and of their wives or widows. The sickness is distinguished into various kinds, according either to its degree or its duration; and a different rate of allowance is appropriated to each. Bedfast, walking, and permanent sickness or disability, form one scale; while sickness of the 1st, 2d, 3d and 4th quarters or periods of 3 months, and sickness of unlimited duration, form another; the rate of allowance in both diminishing progressively at each step of the scale.

In some societies, an annuity is paid to the widows of members; and in others, an allowance is made for the funerals of their children under a certain age. In all, there are some incidental expenses, which arise from the charge which a society must incur for a place of meeting, salary to a clerk to keep the books, and stationery.

Data on which the Contributions and Allowances depend.

4. Such, in general, are the funds and disbursements of Friendly Societies; and it is obvious, that, excepting the advantage arising from fines and expulsions on the one hand, and the disbursements for incidental expenses on the other, all the contributions and allowances depend upon *three* things;—the rate of mortality,—the rate of sickness,—and

the rate of interest at which money may be improved. For, the *extent* of the contributions depends upon the duration of the lives of those who contribute, and their *amount* upon the rate of interest at which these funds are improved; while the allowances depend both upon the *quantum* of sickness an individual undergoes, and upon the duration of his life. Were we, then, possessed of these data, we could compute allowances equivalent to any given contributions. Of these, the *quantum* of sickness only was considered wanting; for many Tables of Life-annuities have been published, in which are shewn, at various rates of interest, what sums paid down at any age will insure an annuity for life after that age. Now, if we knew the average *quantum* * of sickness which a person experiences each year of his age, an allowance for sickness might be considered as a varying annuity, and be calculated by means of these Tables.

Rate of Sickness.

5. When Dr Price, at the request of a Committee of the House of Commons, calculated Tables of the contributions and allowances of Friendly Societies,

* By the average *quantum* of sickness, we mean the duration of sickness expressed in weeks, or parts of a week, which takes place among mankind in general in a district or country, or in a particular society, as the case may be, apportioned equally to each individual. The results of sickness exhibited afterwards, are taken from the observations of a great number of different societies combined.

he was under the necessity, for want of the information which the Highland Society of Scotland has now obtained, of assuming a rate of sickness. He supposed,

That, in societies consisting of persons under 32 years of age, a 48th part of them would always be in a state of inability to work; that is, that among 48 persons under 32, there would occur 52 weeks of sickness, or that $\frac{52}{48} = 1\frac{1}{12} = 1.0833$* weeks of sickness, would be the share of each individual in a year:

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* For the benefit of those who are not familiar with the abbreviated forms of expression used in arithmetic, it may not be superfluous to observe here, that $\frac{52}{48} = 1\frac{1}{12} = 1.0833$ denotes 52 divided by 48 is equal to 1 and one-twelfth, or is equal to 1 and 833 ten thousandth parts;—division being expressed by a number above a line and another below it, and $=$ being the sign of equality.

In the following remarks and tables, for accuracy and facility of computation, instead of several *different* denominations being employed to express the minute parts of time and money, such as days and hours, shillings and pence, *one uniform* denomination is used, which may be applied to every thing. In the arrangements of time and money, a day is the 1 seventh part of a week, and a shilling the 1 twentieth part of a pound; consequently, 2 days are 2 seventh-parts of a week, and 2 shillings 2 twentieth parts of a pound. Here, we suppose, the week divided into seven parts, and the pound into 20 parts, to each of which a particular name or denomination is applied; but it is obvious, that, instead of using these names, we might employ the term *part*, which is common to both, were it understood what proportional part was meant.

The

That among persons from 32 to 42 years of age,—from 43 to 51,—from 52 to 58,—from 58 to 64, this *quantum* of sickness would be increased by a fourth part in each period. Consequently, the

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The arithmetical expressions denoting such *parts* of things, are called Fractions, and are put in the form of one number above a line, and another below it, as $\frac{1}{7}$th, $\frac{1}{20}$th. The lower number denotes or names the number of parts into which the thing is supposed to be divided, and is thence called the *denominator*; and the upper marks the number of these parts, and is called the *numerator*. The divisions of time and of money ordinarily employed are such as have been dictated either by nature or the consent of mankind; but it is manifest, that we might suppose a *week*, and a *pound*, divided into a different number of parts, from those in common use; and further we might suppose both divided into the same number of parts. This would produce a still greater uniformity, as the parts in both cases would bear the same relation to their wholes. Thus, if we were to suppose every thing divided into 10 parts, 10 would be always the denominator of the fraction, and, on that account, would not need to be put down, provided some mark were used to distinguish the *numerator* of the fraction from a whole number or integer. But, as it might be necessary to make use of smaller parts than tenths, we might extend the divisions by multiplying by 10, 100, 1000, or any power of 10, since, to multiply by these, we have only to annex ciphers. If a point prefixed, however, was used to distinguish the fraction from the whole number, the ciphers would fall to be inserted between the point and the numerator, upon the principle, that, from the very nature of our arithmetic, a figure is diminished in value 10 times every place it is removed to the right, and that ciphers are employed to fill the vacant places.

Thus

average *quantum* of sickness of an individual at different ages would, if expressed in weeks, and ten-thousandth parts of a week, stand as follows;

Thus we might express	$\frac{1}{10}$	by .1	denoting one-tenth.
	$\frac{1}{100}$	by .01	one-hundredth.
	$\frac{1}{1000}$	by .001	one-thousandth.
	$\frac{1}{10000}$	by .0001	one-ten-thousandth.

Such fractions have been called decimals, because the *denominator* is 10, or some power of 10.

For the same reason, that putting ciphers between the point and the figure multiplies in whole numbers and diminishes in decimals, putting ciphers on the other side of the figure produces no effect on either; and, therefore, .1, .10, .100, .1000, all denote a fraction of the same value, viz. one-tenth, although the thing is supposed to be divided into a different number of parts; for $\frac{1}{10}$ is the same as $\frac{10}{100}$ and $\frac{100}{1000}$ and $\frac{1000}{10000}$. The consequence of this is, that addition, subtraction, multiplication, and division of decimals, are performed exactly as in common Arithmetic; the only difference being, that we have besides to ascertain the place of the decimal point. In addition and subtraction, having placed the decimal points under one another, and filled up the decimals, or supposed them to be filled up, all to the same number of figures or places with ciphers, the *same number* of decimal figures or places must be made in the result as in each of the lines. In multiplication, the number of decimal places in the result must be the *sum* of those in the multiplier and multiplicand; and, in division, it must be the *difference* of those in the divisor and dividend. Thus, the sum, difference, product and quotient of 8.085 and 1.96, is 10.045, 6.125, 15.84660, and 4.1 respectively.

Addition.	Subtraction.	Multiplication.	Division.
8.085	8.085	8.085	
1.96	1.96	1.96	$\frac{8.085}{1.96}$ = 4.1 Quot.
Sum 10.045,	Dif. 6.125,	Prod. 15.84660	

The

Under 32 years of age	1.0833	weeks of sickness,
From 32 to 42	1.3541	do.
43 to 51	1.6249	do.
51 to 58	1.8957	do.
58 to 64	2.1666	do.

6. This *rate* of sickness differs considerably from that obtained from the Returns made to the Highland Society; the *quantum* being greater in every period except the two last. For, from these Returns, it appears,

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The mode of expressing a fraction is the same as the mode of expressing division, and, therefore, a proper fraction may be considered as denoting, that the numerator is to be divided by the denominator, although the division cannot actually be performed, on account of the numerator being less than the denominator. The consequence of this is, that to multiply both the numerator and denominator of a fraction by the same number, does not alter its value; and, therefore, to convert a vulgar fraction into a decimal one, we have only to multiply the numerator by 10, 100, 1000, or any power of 10, that is, annex any number of ciphers necessary to enable the division to be performed, and the quotient is the decimal wanted.

From the very nature of numbers, it must frequently happen that this division may be continued without termination; but as the decimal figures always decrease a tenth in value by each remove to the *right* from the point, decimals may be stopped, except in long calculations, at three or four places, without any great degree of error; and even in continued multiplications, when the decimals are stopped at a given place, we have only to increase the last decimal figure by 1, if the next figure was to be 5 or above it, in order to compensate for cutting short the decimals.

To

That, among 23,509 persons betwixt the 20th and 30th year of their age, 13,907 weeks of sickness take place in a year, and consequently, that $\frac{13,907}{23,509} = .5916$, or 5916 ten thousandth parts of a week of sickness, is the average of an individual:

That, among 36,261 persons betwixt 30 and 40 years of age, the *quantum* of sickness amounts to 24,894 weeks, and the average to an individual is $\frac{24,894}{36,261} = .6865$ parts of a week:

That, among 25,119 persons betwixt 40 and 50 years of age, the *quantum* of sickness is 25,806 weeks, and we have $\frac{25,806}{25,119} = 1.0273$ weeks as the sickness of each person:

That, among 12,598 persons, betwixt 50 and 60 years of age, there occur 23,691.5 weeks of sickness, and consequently we have $\frac{23,691.5}{12,598} = 1.8806$ weeks as the share of each :

To find the value of a decimal of a *higher* denomination in integers of a *lower* denomination, we have only to multiply the decimal by the number which expresses the quantity of the lower denomination contained in the higher, and the integer is the value. Thus, to find the number of days expressed by .621 of a week, we have to multiply by 7, because 7 days make a week, and the integer in the product 4.347, gives the number of days, and the decimal the fraction of a day.

It may require some apology for inserting here what may be found in every Book of Arithmetic, but as it was our wish to omit nothing which might occasion an obstacle to any person in understanding the following pages, we trust we shall be excused for having made a few general observations upon decimal fractions, which we shall have occasion to use so frequently.

Lastly, That, among 4548 persons betwixt 60 and 70 years of age, the *quantum* of sickness or inability to work extends to 25,622 weeks, making an average of $\frac{25,622}{4,548} = 5.6337$ weeks of sickness to an individual in that period of life.

The rate of sickness then will stand thus:

From 20 to 30 years of age	.5916	weeks of sickness,
30 to 40	.6865	do.
40 to 50	1.0273	do.
50 to 60	1.8806	do.
60 to 70	5.6337	do.

According to this rate, each individual, taking an average of mankind in this country, or at least of men in Friendly Societies, from the 20th to the 30th year of his age, will experience 5916 ten-thousandth parts of a week of sickness, or somewhat more than half a week each year upon an average of these 10 years; or will experience altogether during that period 5 weeks and 916 thousandth parts of a week, or nearly 6 weeks: while, from the 60th to the 70th year of his age, he will experience each year 5 weeks and 6337 ten-thousandth parts of a week, or somewhat more than 5 weeks and a half; or $56\frac{1}{3}$ weeks in all during these ten years.

And the whole *quantum* of sickness which an individual will experience from the 20th till the end of the 70th year of his age, will be 98 weeks and 197 thousandth parts of a week.

7. The *quantum* of sickness or inability to work among persons *above* 70 years of age given in the

Returns, cannot be considered as accurately representing the general average extent of sickness at that period of life; for very few of the Friendly Societies of which we have accounts, have existed so long as to allow the members to reach extreme old age; so that, if it be desired to give allowances to persons above 70, the only accurate way in the present state of our knowledge, seems to be, to give a fixed annuity or annual allowance to all who shall survive that age.

With regard to the *quantum* of sickness among persons below 20 years of age, as the different societies from which we have Returns commence their allowances at different ages, we cannot determine with accuracy the number of years of which the Returns give the average sickness under 20; and, for this reason among others, it has been thought proper, in the following calculations, to assume 21 as the age at which the allowances commence.

Different kinds of Sickness.

8. The Returns do not give the different *kinds* of sickness with sufficient precision to afford correct data for shewing the effects of varying the allowances, and even if they did, to attempt to shew these effects would render the computations too complex. On this account, in the following calculations, one uniform rate of allowance has been adopted for sickness of all kinds. The following general proportion between the different kinds of sickness, however, is drawn from the Returns, and may be taken as an

approximation to the true one, till future observations afford a better standard.

Of 10 weeks of sickness among persons of all ages under 70

	2	may be assumed as	Bedfast Sickness,
	5	- - -	Walking do.
	3	- - -	Permanent do.
In all	10		

Or, if the allowances are regulated by the duration of sickness, then, of 10 weeks of sickness, it may be assumed, that

	$2\frac{1}{2}$	weeks will be Sickness of the	1st Quarter,
	3	- - - - -	2d and 3d do.
	$4\frac{1}{2}$	- - - - -	unlimited duration.
In all	10		

Annuity Tables.

9. Viewing the contribution of a member of a Friendly Society, as an annual payment corresponding to an annuity for sickness, we might now proceed to calculate the value of allowances corresponding to certain contributions, if we could readily fix upon an Annuity Table. But, upon examining the different Tables of Life Annuities, we find a great diversity in the values of these annuities. Thus, according to Dr Price's Northampton Table, the value of an annuity of L. 1 for life, after 20 years of age, (at 4 per cent. interest,) is L. 16.033, or L. 16 : 0 : 8; while, according to Mr Milne's Car-

lisle Table, the value of the same annuity, at the same rate of interest, is L. 18.363, or L. 18 : 7 : 3.

Mortality Tables.

10. This difference arises from the different Tables of the rate of Mortality, from which these annuities are calculated. Mortality Tables are formed from observations made on the proportion between the number of the living and the number of the deaths, in the same year of age. The number of the living, at different ages, however, has oftener been inferred from the number of the deaths, and the state of the population at different times, than ascertained from actual observation. No observations of this kind, to any extent, have been made for Scotland; and those for different parts of England vary considerably. Dr Price's Table of Mortality, founded upon observations made at Northampton, was formerly regarded as the best for England in general; but, of late, an impression seems to prevail, that the rate of Mortality, in that Table, is too high. Accordingly, Mr Milne has lately published a Table, founded upon observations made at Carlisle, in which the rate of Mortality is much lower; and which he endeavours to shew to be applicable to England in general. According to these two Tables, the proportion of the deaths to the living, at different ages, is,

	Northampton.	Carlisle.
Between 20 & 30,	1 to 63.7	1 to 132.60
30 40,	1 53.5	1 94.44
40 50,	1 41.7	1 69.72

		Northampton.		Carlisle.	
50	60,	1	29.9	1	54.74
60	70,	1	20.3	1	24.24
70	80,	1	11.0	1	12.04
80	90,	1	5.0	1	5.69
above	90,	1	2.4	1	3.50

Whence, it appears, that, according to the Northampton Table, one out of 63 persons, omitting decimals, of any age between 20 and 30 dies annually upon an average of these 10 years; while, according to the Carlisle Table, only one death occurs in a year among 132 persons living that year: so that, the one Table represents the Mortality between 20 and 30 double of that which the other does.

11. These Tables were made at different periods; but although it be the general opinion, that the average duration of life has increased, yet the difference between them cannot be ascribed entirely to that cause, and something must be allowed to sources of error incident to the subject, from which, perhaps, neither is perfectly exempt. Both labour under the disadvantage of being limited to a small spot of country, which accidental causes may have rendered healthy or unhealthy. Dr Price's Table is founded upon the assumption, that the population of Northampton continued stationary for 46 years, and Mr Milne's observations extend to a period of 9 years only.

The observations most free from objection seem to be those which have been made in the kingdom of Sweden and Finland. They are confined neither to a short period of time, nor a small extent of terri-

tory; and they go fully to prove the increased average duration of life in that country. The latest Swedish Table *, which, however, is but for a small number of years, gives the following proportion:

Between 20 &	30,	1	to	134.86
30	40,	1		102.96
40	50,	1		70.07
50	60,	1		39.81
60	70,	1		20.43
70	80,	1		8.95
80	90,	1		4.30
above	90,	1		2.38

12. Still, what may be correct for Sweden may not be correct for Britain. The different enumerations of the inhabitants of this country, by order of Government, do not yet, it is thought, afford sufficient data for forming correct Tables of Mortality. The last is the only one which distributes the people into classes, according to their ages; but, although the total number of deaths, which occurred in England during the preceding 10 years, is given, yet the ages of the persons at their deaths are not given. Mr Cleland, however, in a work upon Glasgow, has given the total number who died in that city, arranged in classes according to age, for 1822, the year succeeding that in which the last census was taken, and in which the number of deaths differed only 4 from that of the preceding year; so that the deaths, in 1821, may be considered, without great error, as classified. From comparing the number of these at

* See Suppl. to Encyclopædia Brit., Vol. v. Art. Mortality.

different ages with the number of persons living at the same ages, we find the following proportion:

		Males.		Females.		Both.	
Between 20 &	30,	1 to	81.5	1 to	137.5	1 to	107.5
30	40,	1	73.5	1	81.1	1	77.5
40	50,	1	58.7	1	74.2	1	66.0
50	60,	1	41.5	1	47.5	1	44.6
60	70,	1	20.7	1	23.6	1	22.3
70	80,	1	8.1	1	9.6	1	8.9
80	90,	1	5.9	1	6.6	1	6.3
above	90,	1	1.6	1	2.9	1	2.4

13. This Table exhibits the ratio of the number of the deaths to the number of the living, for one year only, and therefore cannot be relied on as shewing the general rate of mortality in Glasgow; for, in the year 1820, the number of deaths was 729 less, while in 1818 it was 506 more than in 1821. But as it gives an intermediate rate between that of the Northampton and Carlisle Tables, it serves, in some measure, to confirm the opinion, that the safest method, in our present uncertainty, is to adopt a Table, which shall be an average of the three Tables first mentioned, the Northampton, Carlisle and Swedish.

This gives the following proportion:

Between 20 &	30,	1 to	95.50
30	40,	1	76.67
40	50,	1	58.14
50	60,	1	40.28
60	70,	1	21.90
70	80,	1	10.48
80	90,	1	5.17
above	90,	1	2.50

14. This Table must be considered also as an average Table for males and females, and, therefore, as it is well known that the mortality of males and females is different, which, indeed, appears from the above observations at Glasgow, it may give the mortality of males too little, and of females too much; but we are so deficient in data to make the distinction, that we run as much risk of error in attempting it, as in regarding the mortality of the sexes the same.

15. As no annuities have been calculated from the latest Swedish Table of observations, if we wish to adopt this Average Table, it will be necessary to calculate a new Table of Annuities. This we shall do, indirectly however; and as part of a system, which, while it shews the various steps of the process of calculation, and thereby, it is hoped, may render the subject plain, even to those not very intimately acquainted with figures, will facilitate the means of ascertaining the state of Friendly Societies at any time.

II.

EXPLANATION OF THE CONSTRUCTION AND CONTENTS OF THE TABLES.

16. Before proceeding to explain the principles on which the following Tables are constructed, it will be proper to state, in a few words, the limitations and assumptions, which it will be convenient to make in the calculations.

In calculating the allowances equivalent to certain contributions, it will be convenient to compute each allowance separately, as—allowance for sickness from 20 to 70 years of age,—annuity for old age after 70,—allowance for funerals of persons above 20,—and annuity for widows. With regard to allowances for the funerals of children under a certain age, it was thought, that, as the calculation of these involves another principle, the prolifickness of marriage, and, as such allowances are rarely made in Friendly Societies, they might be omitted.

Experience seems to shew, that, of those who enter into Friendly Societies, almost all marry early; and consequently that the difference of age between the husband and wife is much less amongst such persons than in the middle ranks of life; and therefore it has been assumed, for convenience of computation, that all marry, and that the ages of husband and wife are equal. No provision is made for second marriages, as we have no data for ascertaining the

number of these, and besides, in that case the ages would generally differ *.

It will be convenient also, to consider the contributions and allowances as paid annually, and the contributions to continue to be paid even by those who are receiving allowances for sickness. It has been thought proper, on account of the difficulty experienced by members of Friendly Societies, of paying contributions in old age, to hold the contribution as terminating at the end of the 70th year of age. For facility of computation, L. 1 has been assumed for the annual contribution, and decimals of L. 1 have been employed, instead of shillings and pence. It has been judged proper to adopt 4 per cent. as the rate of interest.

General Principles upon which the Tables are constructed.

17. Tables of mortality shew, out of a given number, born at the same time, both the number who die, and the number who remain alive, each year, till all be dead. Now, if we take from any mortality table the number of persons alive at 20 years of age, and suppose that these form a society which continues together till death, but admits no new mem-

* These assumptions simplify the calculations: and if, on the one hand, the assumption, that all marry, may add to the number of widows; the other assumption, that the husband and wife are of the same age, has a tendency to diminish the number of widows in our calculation; since, even in the labouring classes, the age of the wife at marriage is, upon the whole, less than that of the husband.

bers, and that each contributes a given sum annually, and receives a given allowance for each week of sickness he undergoes, so long as he lives; then, if the contributions and allowances be such that there is neither surplus nor deficiency of funds when all are dead, these contributions must be equivalent to the allowances, and proper for the wellbeing of the society.

If, instead of the allowances being deducted from the contributions annually, and thus disappearing, as in practice, we were to suppose both the contributions and the allowances to be laid out and accumulated at interest separately, for the same number of years, or till all the members of the society were dead, then the total accumulated amount of each would, if the contributions and allowances were equivalent, as supposed above, be the same. This circumstance points out a method of correcting the assumed contributions, if they are not equivalent to the assumed allowances; for, if the total accumulated amounts are not equal, to find the *equivalent* allowance we have only to raise or diminish the *assumed* allowance, in proportion as the accumulated amount of allowances is less or more than the accumulated amount of contributions.

18. Instead of supposing the contributions and allowances to continue till all the members of such society be dead, we may suppose them to terminate after 50, or any given number of years from the commencement; and, by finding the accumulated amounts for that space of time, ascertain, as before,

the allowances equivalent to the contributions: Or, we may suppose the annual contributions to cease, after a certain number of years, and the allowances to commence only then, and continue till all be dead, while the amount of the contributions is still increasing by the addition of interest for the same period; as, for instance, an annual contribution commencing at 21 years of age, and continuing till 70, in order to create a fund for an annuity during life, after the latter age.

19. Again, as the Mortality Table gives the number of deaths for each year, we may find the accumulated amount of an allowance for each funeral; and, by comparing this amount with that of a given contribution as before, determine what allowance that contribution can afford.

20. *Lastly*, As we can deduce from a Mortality Table, the number of widows alive each year, belonging to such society, supposing all its members to have been married; by finding the accumulated amount of an allowance or annuity to each widow, we may ascertain as before, what allowance is equivalent to a given contribution.

21. Now, if we compare the annual amounts of these allowances with those of the contributions, it is obvious, that, by deducting the former from the latter, we find the stock of the supposed society for each year; and, by dividing this stock by the number of members living that year, we ascertain the stock of each individual. And this individual stock, except in the case of the Fund for Annuities to Widows,

is manifestly the sum which a person of the same age as the members of this society ought to pay upon entering it, in addition to the fixed annual contribution, in order to be entitled to the same allowances as the members.

With regard to the widows' fund, as the contributions and the annuity depend upon the lives of two different persons, the stock acquired by commencing to contribute at one age, cannot shew the sum which a person ought to pay, if he begin to contribute at a later age: For a different series of widows arises, according as we begin deducing the series at a different age, and claims for annuities must have arisen, with which future entrants should not be burdened; so that, to determine the entry-money proper to be paid, in order to put an entrant at a later age upon the same footing as those commencing at 21 years of age, it would be necessary to form a Table of widows for every age, and thus find the annuity commencing at that age, and thence deduce the entry-money. This may be done by a process much shorter, though perhaps not so clear in all the steps of it. It has been deemed sufficient to exhibit the case of 21 years of age, as an example, according to which the value of the annuity may be found for any age.

22. Again, if we *discount* the total accumulated amounts of contribution for as many years as these amounts have taken to accumulate, we ascertain the sum which, paid down at once, by the members of this society, at 20 years of age, is equivalent to

the allowances, without any annual contributions; and, if we compare the amounts arising from the accumulation, by interest, of this single contribution, with those of the annual contributions for each year, by deducting the latter from the former we ascertain the value at any age, of the future contributions of the society, and consequently of each member; since we have only to divide by the number of members living at that age.

23. Again, if we add the individual stock for any age, and the value at that age of the future contributions, we find the sum to be paid down, in order to compensate for past contributions; and, at the same time, supersede all future contributions; or, in other words, we find the value at that age of the future allowances. Whence, it follows, that, from being able to determine the present value of the future allowances of each of the members of a society, and also the present value of their future contributions, we can, by deducting the amount of the latter from that of the former, ascertain the stock which the society ought to be possessed of, to be enabled to meet the demands that may be made upon it.

24. *Lastly*, If we *multiply the value of the future allowances, at any age, by the given annual contribution, and divide the product by the value of the future contributions at that age*, we find the sum to which the annual contributions after that age must be increased, in order to compensate for not paying down a sum equal to the stock or value of past contributions at that age. And, if

we *multiply the value of the future contributions, at any age, by the given allowance, and divide the product by the value of the future allowances at that age*, we find the sum to which the allowance must be diminished after that age, in order to compensate for not paying down a sum equal to the value of the past contributions, and also to supersede the necessity of increasing the annual contribution.

For, in the first case,

As the present value of the future contributions :
To the present value of the future allowances : :
So the given annual contribution :
To the increased annual contribution required.

And, in the second case,

As the present value of the future allowances :
To the present value of the future contributions : :
So the given allowance :
To the diminished allowance required.

Or, having found the increase of annual contribution by the first case, the diminution of allowance may be found, by reducing the allowance found for 21 years of age, in proportion as the contribution commencing at the given ages is increased from that of 21.

Particular Explanation of the Tables.

25. Having premised these general observations regarding the construction of the Tables, we now go on to state and explain more particularly the contents

of each of them in order. They comprise five different sets of Tables, viz. Preliminary Tables, and Tables of four different Schemes of Allowance—For Sickness,—for Old Age,—for Funerals,—for Widows.

The Preliminary Tables are four in number, and are so called, because they form the foundation of all the rest. To each Scheme, except the fourth, which requires two auxiliary Tables besides, belong six Tables; but of these three are Tables of Contribution, and as the contribution was assumed to be the same for all the schemes of allowance, these three tables are common to them all.

Mortality Table.

26. In Table I. of the Preliminary Tables, are shewn, out of 1005 persons of the same age, all in the beginning of their 21st year, the numbers who will be alive at the beginning of each subsequent year, till all be dead; also the numbers who die during each year; and the numbers who are alive, upon an average, throughout the year, or at the middle of the year *.

* In forming this table, the three tables of which it is an average, were reduced to the same *radix*, or number, at the completion of 20 years of age, the corresponding numbers of each added together, 1005 assumed as the radix for a new table, and to avoid fractions the nearest whole numbers used. The average number alive throughout the year is a mean between those alive at the beginning and those alive at the end of any year.

From this Table it appears,

That of 1005 persons living at the beginning of the 21st year of their age, 10 die during that year, and the average number alive throughout the year is 1000 :

That 915 reach the beginning of their 30th year in the course of which 10 die :

That 681 reach the beginning of their 50th year, in the course of which 13 die :

That only 324 survive the beginning of their 71st year, in which 23 die :

And that none at all are alive at the beginning of the 96th year *.

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* From a Mortality Table, the chance of life is estimated in the following manner. If, in a great number of cases or *trials* of one case, where in a single case or trial one of two events must happen, but it is uncertain which shall happen, it is found, that the one event happens so many times, and the other so many times; we say, that there are so many chances for the one, and so many for the other: and the proportion of each of these numbers of chances to the whole number of chances expressed by the number of cases, denotes the chance or probability of each event happening in an individual case; and, consequently, is expressed by a fraction whose denominator is the whole number of chances, and its numerator the number of chances for the one event. If there are two cases, in which the same event is to happen, the joint chance is estimated by the chance of the one multiplied by the chance of the other; for, the chance of the event happening in either case, may coincide with each of the chances for the event happening in the other.

Now, a Mortality Table may be supposed to represent, out of so many cases, expressed by the number of persons living, at

Table of Widows.

27. In Table II. of the Preliminary Tables, are shewn, out of 1005 married women, all commencing the 21st year of their age at the same time,

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at the beginning of the table, the number of chances of an individual surviving any given age; and, therefore, the chance or probability of a person living from one period to another, may be expressed by the fraction whose denominator is the number living at the first period, and numerator is the number at the second; and the chance of two given persons, as a man and his wife, both living from one period to another, may be expressed by the chance of life of the one, multiplied by the chance of life of the other; and, if these chances be the same, as in the case of a man and his wife, being of the same age, and the rate of mortality of males and females being supposed the same, the chance of both being alive from one period to another, is expressed by the square of the chance of either of them. Thus, the chance of a person living from 21 to 31, is by the above Table of Mortality, $\frac{905}{1005}$; and, of two persons of the same age, $\frac{905 \times 905}{1005 \times 1005} = \frac{819025}{1010025}$.

Now, as the former chance denotes that of 1005 persons living at twenty-one, 905 will survive 31; so the latter chance may be considered as expressing that of 1010025 married couples of the same age at 21, only 819025 will survive 31; and thus we might form, by squaring each of the numbers in the Mortality Table, a table of married couples, of the same age, surviving different periods. To compare this Table, however, with the Mortality Table, it would be necessary to divide each of the numbers by the radix or number at which the commencement was made. In the above example, dividing 1010025 and 819025, each by 1005, we would find, that, out of 1005 married couples of the same age at 21, only 815 would be living united at 31: whereas it appeared, that, of 1005 single persons, 905 survived.

and whose husbands are of the same age, the number of widows who will be alive each year, upon an average, till all be dead *.

* From what was said in the former note, it is clear, that we can form a table of the number of married couples, surviving all ages, out of 1005 of the same age at 21, and of course determine the number of *married women* surviving any age. Now, the Mortality Table, as it is for both sexes, shews the total number of women, whether married or not, surviving any age, out of a given number alive at a given age; and, therefore, if we deduct the number in the *former* Table at any age, from the number in the *latter* at the same age, we find the number of widows surviving that age, out of 1005 married women in the 21st year of age. In this manner was the Table of Widows formed, except that fractions are omitted, and the number found for the end of the year is inserted for the middle of it, to make a small allowance for the greater longevity of females.

In the same manner, commencing at any other age than 21, we can find the number of married couples, and consequently the number of widows, by squaring the number in the Mortaity Table, at the given age, at which it is desired to know the umber of widows,—dividing the product by the number in the Mortality Table, at the age at which all were married, and subtracting the quotient from the number in the Mortality Table, at the given age.

Thus, if we wished to know the number of widows at 60, out of a given number of married couples at 40, we find, from the Mortality Table, that 536 women are alive at 60, out of 806 who were alive at 40; therefore 536 multiplied by 536, and divided by 806, gives 356 for the number of married women alive at 60, out of 806 alive at 40; and 356 subtracted from 536, leaves 180 for the number of widows, out of 806 married couples; and we have only to reduce these in proportion to the given number of married couples. Thus, if the given number was 100, then the number of widows would be 22, and rather more; for 806 : 100 :: 180 : 22.3.

From this Table, it appears, that the number of widows increases rapidly at first, then more slowly, till it reaches the maximum, when it begins to decrease, at first slowly, but afterwards more rapidly. Thus, there are 10 widows alive, upon an average, in the 21st year of their age; 90 in the 30th; 224 in the 50th; 252 in the 60th, which is the greatest number alive at one time. The number then decreases, so that in the 71st year of their age, only 216 are alive, and none at all reach the 96th year.

Table of Sickness to an Individual.

28. In Table III. of the Preliminary Tables, is shewn the *quantum* of sickness, expressed in weeks, and thousandth parts of a week, which an individual undergoes, taking an average of mankind, during each year of his life, from 20 to 70. In the Returns, the sickness is given only for periods of 10 years, but as it receives an increase in each period, we may conclude, that if it had been given for each year, instead of each decade, we should have found it to increase annually. By examining the rate at which it does increase, from one period of 10 years to another, we may determine nearly the rate at which it would increase from year to year, and thus fill up the intermediate years. In this manner, the *quantum* of sickness has been ascertained, and inserted for each year, just as, in Tables of Mortality, the number of the living is interpolated from similarly imperfect data.

From this table, it appears that the annual *quan-*

tum of sickness increases very slowly for many years at first, but afterwards very rapidly. Thus, in the 21st year of age, it is only .575, or 575 thousandth parts of a week, or little more than 4 days to each person. This quantity increases gradually, till it becomes .621 of a week, or 4$\frac{1}{3}$d days in the 30th year of age, making the average of the 10 years, from 20 to 30, .5916 of a week or 4$\frac{1}{10}$ days, as the Returns give it. In the 50th year of age the *quantum* of sickness is only 1.361 weeks, or 1 week and 2$\frac{1}{2}$ days; and in the 60th, 2.346 weeks, or 2 weeks and 2$\frac{1}{2}$ days nearly; but in the 70th year of age, it amounts to 10.701 weeks, or 10 weeks and 5 days nearly.

Table of Sickness in a Society.

29. In Table IV. of the Preliminary Tables, is shewn the *quantum* of sickness which would take place annually from 20 to 70 years of age among the average number of persons alive throughout the year, out of 1005 persons, all commencing their 21st year at the same time. Thus, in the 21st year of age, as one person experiences .575 of a week of sickness, 1000 persons, the average number alive that year, will undergo 575.000 or 575 weeks of sickness. In the 40th year of age, as only 800 are alive, and each undergoes .758 of a week, the *quantum* of sickness will be 606.400, or 606$\frac{2}{5}$ weeks. And in the 70th year of age, although the number of survivors is only 336, yet as 10.701 weeks of sickness fall to the share of each, the whole sickness among that number amounts to 3595$\frac{1}{2}$ weeks.

Contribution Tables of all the Schemes.

30. In Table I. of Scheme I., are shewn the amounts that would arise annually, from an annual Contribution of L. 1, from each of 1000 persons, all in the middle of the 21st year of their age, when they commenced contributing, and continuing to contribute, for 50 years, provided they lived so long; those who survived that period ceasing to contribute. These 1000 persons may be supposed to constitute a society, admitting no new members, but continuing united till all its members be dead.

The annual contribution is supposed to be made at the middle of the year, and consequently by the average number of persons alive throughout the year, as shewn in the Mortality Table; and the money is supposed to be laid out annually at 4 per cent. interest.

The annual contributions,—the amounts without the interest,—the interest,—and the amounts with the interest, are each put down in separate columns.

From this Table it appears, that, in the 10th year from the commencement of such contributions, when the number of survivors is 910, all in the 30th year of their age,

The accumulated amount, without the interest of that year, is	L. 10,187.096*	or L. 10,187	1	11	
The interest of that year is	407.484	or 407	9	$8\frac{1}{4}$	

* A rule for converting decimals of a pound into shillings and pence, is given at Article 47.

The amount with that interest is	L. 10,594.580	or	L. 10,594 11 $7\frac{1}{4}$
And the sum of the annual contribution is	910.000	or	910 0 0

In the 30th year of the scheme, when the number of contributors is reduced to 675, in the 50th year of their age,

The accumulated amount, with the interest of that year, is	L. 48,565.427	or	L. 48,565 8 $6\frac{1}{2}$
The annual contribution	675.000	or	675 0 0

Lastly, in the 51st year of the Scheme, when only 313 persons survive, and the contributions cease,

The total accumulated amount is	L. 128,753.706	or	L. 128,753 14 $1\frac{1}{2}$

31. When we accumulate this sum at 4 per cent. interest for 25 years more, or till all the members of the supposed society be dead, we find that it amounts to L. 343,236.307 or L. 343,236 : 6 : $1\frac{3}{4}$; and, by discounting this sum at the same rate of interest, for 75 years, or the same number of years which it has taken to accumulate, we ascertain that the sum of L. 18,117.271 or L. 18,117 : 5 : 5, will, when accumulated at 4 per cent. interest for 75 years, amount to L. 343,236.307.

Accordingly, in Table II. of Scheme I., are shewn the amounts arising annually from the accumulation by interest at 4 per cent., of the above mentioned sum of L. 18,117.271 for 75 years. The amounts and interests are put down in separate columns.

From this Table it appears, that, at the end of the 10th year from the commencement of the accumulation, the sum would be L. 26,817.986, or L. 26,817 : 19 : $8\frac{3}{4}$.; and at the end of 50 years, it would amount to L. 128,753.706, exactly the same sum as the total amount of the annual contribution of L. 1, for the same number of years in Table I. of Scheme I. Whence it follows, that if the Society of 1000 persons supposed above, were to contribute at once in their 21st year L. 18,117 : 5 : 5, or each L. 18 : 2 : 4, this single contribution would be equivalent to an annual contribution of L. 1 from each, for 50 years if in life. It follows also, that the amount for any year of age in this table is equivalent to the amount of the contributions at that age in Table I. of Scheme I., together with the value at that time of all the future contributions after that age. It will be seen afterwards for what purpose the accumulation is carried on for 25 years more.

32. In Table III. of Scheme I., the amounts arising from the *annual* contribution in Table I. of Scheme I., and the amounts arising from the *single* contribution in Table II. of Scheme I., are compared for each year, and the excess of the latter above the former stated, and the share of each surviving contributor in that excess. This excess obviously shews the sum which, paid down at that time, and accumulated with interest for as many years as have to run of the annual contribution, would be equivalent to the total amount of the annual contributions *after* that time, or, in other words, shews the

present value of the future annual contributions. For, as the amounts of the single contribution shew, each year, the present value of the whole annual contributions both past and future, if the amounts of the past annual contributions be deducted, the sums remaining must be the present values of the future annual contributions *.

From this Table it appears, that, in the 10th year of our supposed society, when the number of members is 910 in the 30th year of age, the value at that time of the whole future contributions would be L. 15,191.945, or L. 15,191 : 18 : 10$\frac{3}{4}$, and consequently the value of the future contributions of *each* member L. 16.6944, or L. 16 : 13 : 10$\frac{1}{2}$; and, therefore, if any member were to pay down this sum, he should not be obliged to pay any future annual contribution.

In the 30th year of the Scheme, when the members are reduced to 675 in the 50th year of their age, the value of the future contributions of each is L. 11.7571, or L. 11 : 15 : 1$\frac{3}{4}$, and this sum paid down by a member would render it unnecessary for him to pay any annual contributions in future. And, in general, if a society were composed of persons of all different ages, from 20 to 70, contributing each annually L. 1, till he reached his 71st year, if he

* As a sum of money is the same, whether it be *contributed* to a fund, or *received* from a fund by an individual, these values are just the values of an annuity of L. 1, not for life, but to the 71st year of age, calculated however from the middle of the *year of age*, and increased by L. 1, as the first payment is here supposed to be made at the commencement of the *year of interest*, and not at the end, as in common Annuity Tables.

lived so long, the present value of the future contributions of each would be found opposite his age in this table.

Distribution Tables of Scheme I.

33. Having ascertained, by previous calculation, which it is unnecessary to exhibit, that an annual *allowance* or distribution of L. 1, for each week of sickness, which the members of our supposed society might experience from 20 to 70 years of age, as shewn in Table IV. of the Preliminary Tables, when accumulated in the same manner, and at the same rate of interest, as the annual contribution of L. 1, in Table I. of Scheme I, amounts to L. 125,036.953, or L. 125,036 : 19 : 0$\frac{3}{4}$: it follows, that if this sum arises from an accumulated distribution of L. 1, the sum of L. 128,753.706 will arise from an accumulated distribution of L. 1.029725 or L. 1 : 0 : 7, for each week of sickness which the members of the Society might experience from 20 to 70 years of age; for L. 125,036.953, is to L. 1, as L. 128,753.706, is to L. 1.029725 *.

* As similar proportions, obtained in the same way, will be stated afterwards, and as it is desirable that nothing should be passed over which may be misunderstood by members of Friendly Societies, it may be noticed here, that the three first terms of this proportion are supposed to be placed, as in the stating of a question of the Rule of Three, thus

L. 125,036.953 : L. 1 : : L. 128,753.706.

And the question being wrought in the usual way, by multiplying the second and third terms together, and dividing the product by the first, the sum of L. 1.029725 is obtained, which forms the fourth term of the proportion.

Accordingly, in Table IV. of Scheme I, are shewn the amounts that would arise annually from an *annual distribution* of L. 1.029725 for each week of sickness, that takes place during the space of 50 years among 1000 persons, all in the middle of the 21st year of their age when the distribution commences. The annual distribution, like the annual contribution in Table I. of Scheme I., is supposed to be made at the middle of the year, and consequently to the average number of persons alive throughout the year, as shewn in the Mortality Table; and the money is supposed to be laid out annually at 4 per cent. interest. The annual distributions,—the amounts without the interest,—the interest,—the amounts with the interest, are each put down in separate columns, as in Table I. of Scheme I.

From this Table it appears, that, in the 10th year from the commencement of such distribution, when the number of the society surviving is 910, all in the 30th year of their age, and the average sickness of an individual is .621 of a week, and consequently, the whole number of weeks of sickness to the society is 565.110,

The accumulated amount, without the interest of that year, is - - -	L. 6156.207
The interest of which is, - -	246.248
The amount with the interest, - -	6402.455
The annual distribution that year, -	581.908

In the 30th year from the commencement of the distribution, when the survivors are in their 50th year of age, and the *quantum* of sickness to the society is 918.675 weeks,

The amount, with the interest, is, -	L. 34085.767
The annual distribution that year is, -	945.983

In the 51st year of the Scheme, when the survivors are in the 71st year of their age, and the distributions cease, the total accumulated amount is,

L. 128753.706 or L. 128753 : 14 : $1\frac{1}{2}$.

exactly the same sum as the total amount of the accumulated annual contributions in Table I. of Scheme I., and of the accumulated single contribution at the end of 50 years in Table II. of Scheme I.

34. From this result it follows, that an annual contribution of L. 1 for 50 years, from 1000 or any considerable number of persons, all in the middle of their 21st year, when they begin to contribute, or a single contribution of L. 18.1173, or L. 18 : 2 : 4 from each at that age, is equivalent to, or will afford, an annual distribution or allowance of L. 1.029725, or L. 1 : 0 : 7 for each week of sickness, to the survivors for the same number of years.

35. In Table V. of Scheme I., the accumulated amounts of contribution and distribution in Tables I. and IV. of Scheme I., are compared for each year, and the excess of the former above the latter stated, as also the share of each survivor in that excess. This excess, it is manifest, will be the nett stock of the supposed society, and the share of each survivor in that excess, the stock of an individual member. Were this society to admit new members at any later age than 21, it is obvious, that each of these ought to pay, in addition to the

annual contribution of L. 1, a sum equal to the stock of an individual member of the same age as himself, in order to be entitled to the same allowance as the rest.

It follows, also, that were a new society instituted, *consisting of persons of all ages between 20 and 70*, and the annual contribution of all made L. 1, and the weekly allowance for sickness L. 1 : 0 : 7, then, that all might be upon an equal footing, *each ought to pay down, besides this annual contribution, a sum equal to the individual stock opposite his age in this Table.*

From this Table it appears, that the individual stock of members in the supposed society, increases rapidly at first, but afterwards more slowly, till it reaches the maximum in the 64th year of age, when it declines very rapidly for the few remaining years. Thus, in the 10th year from the commencement of the society, when the number of survivors is 910 in the 30th year of their age, the nett stock is L. 4192.125, and consequently, the share or stock of each member L. 4.6067. If any person, therefore, of 30 years of age, were to be admitted into this society, or if a new society were instituted, consisting of persons all of that age, they ought, in order to be entitled to an allowance of L. 1 : 0 : 7 for each week of sickness, to pay each at first, besides the annual contribution of L. 1, the sum of L. 4.6067 or L. 4 : 12 : 1½.

In the 30th year of the existence of the society, when the number of members is reduced to 675, all in the 50th year of their age, the stock of the

society is L. 14,479.660, and the stock of each member L. 21.4513, or L. 21 : 9 : $0\frac{1}{4}$, which is the sum any person, or society of persons, commencing to contribute at 50, ought to pay down each, in addition to the annual contribution of L. 1, to enable the society to give an allowance of L. 1 : 0 : 7 for each week of sickness.

In the 51st year of the society, when both the contributions and allowances cease, the stock, as ought to be the case, is nothing.

36. As the object of a society, in which the claims upon it for allowances increase as the members advance in age, must be to lay up such a stock, as, when accumulated by interest, and augmented by the contributions expected to be received, will be sufficient to defray all these allowances; the funds of every such society will consist of *two* parts, funds in hand or stock, arising from *past* contributions, and funds in expectation, or the value of *future* contributions; and wherever, as in our supposed society, the contributions and allowances are properly adjusted to each other, these two parts at any period must be equal to the value of all the allowances after that period.

Again, as in the progress of our society, the value of the future contributions must decrease every year, in consequence of the period for contributing as well as for the contributions accumulating at interest being shortened, while the value of the future allowances must increase for a great number of years, on account of the value of the past contributions in-

creasing at a more rapid rate in the early ages, than the value of the future contributions decreases, and must always be greater than the corresponding value of the future contributions, except at the very commencement of the society, when it must be the same; *it follows*, that, to a person or society of persons commencing to contribute at an age later than 21, either the annual contribution must be raised, or the sick allowance diminished, in proportion as the value of the future allowances is greater than the value of the future contributions at the given age.

Accordingly, in Table VI. of Scheme I., the individual stock, as found in Table V. of Scheme I., and the present value of the future contributions of an individual, as found in Table III. of Scheme I., are compared for each year, and the annual sums of both stated in a separate column. These, from what has been already said, must express the values to be paid down at every age, to compensate for what should have been paid before, and to supersede the necessity of paying more; or, in other words, must be the values at these ages of all the future allowances *.

* If it had not been our object to ascertain the values of stock or past contributions *directly*, we might, instead of finding the present values of the future allowances or distributions, as above, by adding the values of the past and future contributions together, have determined them *more directly*, by deducting, each year, the amounts arising from the *annual* distribution in Table IV. of Scheme I. from the corresponding amounts arising from the *single* contribution in Table II. of Scheme I., and dividing the remainder by the number of survivors at each age. For, as the amounts of the *single contribution* shew, each

In the 6th column of this Table, are shewn the sums to which the annual contribution after any age ought to be increased, in order to compensate for not paying down, in addition to the annual contribution of L. 1, a sum equal to the individual stock, if a member enters at that age; or in order to be equivalent to the future allowances.

In the 7th column, are shewn the sums to which the allowances for sickness after any age ought to be diminished, in order to be equivalent to the future contributions, if a member entering at that age should decline paying a sum equal to the stock, or increasing the annual contribution.

From this Table it appears, that if a Society were formed of persons of 30 years of age, and if the contribution were made L. 1 *per annum*, and the sick allowance L. 1.029725, or L. 1 : 0 : 7 *per week*, till they reached the 71st year of age, then each Member must pay down at entry L. 4.6067, or L. 4 : 12 : 1½.

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year, the present value of the whole *annual distributions*, both past and future, the excesses of these amounts above the amounts of the past annual distributions, must be the values of the future annual distributions or allowances.

If it should seem somewhat strange, that the *values* of the future allowances should increase annually for a long period, when the *number* of these allowances to be provided for is actually decreasing every year, it must be remembered, that the great mass of allowances falls in the higher ages, and that the discount on the value of these for one year exceeds the allowances of one year in the early ages; and, besides, that the annual decrease in the number of future allowances is not so great as would seem from Table III. of the Preliminary Tables, owing to the chance of life diminishing

Society; and of L. 5.627782 *per annum*, for life to each Widow left by the members of the Society, will each produce the sum of L. 343236.307.

Since,	£5,916.750:	£1::	£343,236.307:	£58.01095
and,	5,724.572:	1::	343,236.307:	59.95842
and,	60,989.625630:	1::	343,236.307:	5.627782

Now, it appeared from Table II. of Scheme I., that L.343236.307 was the sum to which L. 128753.706 amounted, when accumulated at 4 per cent. for 25 years; and from Table I. of Scheme I., that L. 128753.706, was the total amount of an annual contribution of L. 1 from each of 1000 persons, all in the middle of their 21st year, when they commenced contributing and continuing to contribute for 50 years, provided they lived so long.

Accordingly, in Table IV. of Scheme II., are shewn the amounts arising annually from the accumulation at 4 per cent. interest, of an annuity for life of L. 58.01095, or L. 58 : 0 : 2½, to each person who survives the middle of the 71st year of his age, out of the supposed Society of 1000 persons of the same age in their 21st year.

In Table IV. of Scheme III, are shewn the amounts arising annually from the accumulation as before, of an allowance of L. 59.95842 or L. 59, 19s. 2d., for every death that takes place in such Society from its commencement, till all be dead.

In Table IV. of Scheme IV., are shewn the amounts arising annually from the accumulation as before, of an annuity of L. 5.627782, or L. 5 : 12 : 6½ to each widow, left by Members of the Society, sup-

posing all had been married in their 21st year to women of the same age.

The *total amount* in each of these Tables in the 76th year, from the commencement of the Society, when all are dead, is L. 343,236.307 or L. 343236, 6s. $1\frac{-}{1}$d., exactly the sum to which an annual contribution of L. 1, from the same Society for 50 years, commencing in the 21st, and ending in the 71st year of age, amounts, when accumulated for 25 years more, or till all are dead.

38. In Table V. of Schemes II, III, and IV, the amounts in Table IV. of these Schemes, are compared for each year, with the amounts arising from the annual contribution of L. 1, in Table I. of the Schemes, and its accumulation afterwards in Table II. of the Schemes, and the annual stock is shewn, both of the Society and of each member.

Thus, Table V. of each of these Schemes corresponds to Table V. of Scheme I.

39. In Table VI. of Schemes II. III. and IV. the individual stocks as found in Table V. of these Schemes, and the values at any age of the future contributions, as found in Table III. of the Schemes, are compared for each year, and their joint sums stated, which are the values at any age of all the future allowances. These sums are contained in the 5th column; and in the 6th and 7th, except in Scheme IV., are shewn the sums to which the annual contributions after any age must be raised, in order to be equivalent to the value of the future allowances after

that age, or the allowances diminished, in order not to exceed the value of the future contributions.

Thus, Table VI. of Schemes II. and III. is exactly similar to the corresponding Table in Scheme I.

40. As Table VI. of Scheme IV., from what has been said in Art. 21., only serves for persons commencing to contribute at 21 years of age, the 6th and 7th columns are wanting, and other two Tables are inserted to supply the defects of this Table.

When we have ascertained the value, at any age, of an annuity of L. 1, during the life of an individual, as a woman of a given age, and also the value, at that age, of an annuity of L. 1 on her life, during the period which she and her husband continue both in life, it is obvious, that, by deducting the latter from the former, we obtain the value, at the same age, of an annuity of L. 1 during the remainder of her life, after the death of her husband; and, when we know the value of an annuity of L. 1, we can find the annuity equivalent to any other value or sum, by raising the annuity in proportion as the sum is increased; and therefore can ascertain the annuity to a widow corresponding to an annual contribution, commencing at any age, and continuing till 70.

Also, when we know the ages of the members of a society, and those of the wives and widows belonging to it, we can ascertain the stock of the fund for widows annuities; for we can find the values of annuities both to existing widows and widows in expectation,

and the values of the future contributions; and the differences of these ought to be the stock of the society.

41. In Table VII. of Scheme IV. column 2. are shewn the values, at any given age above 20, of an annual contribution of L. 1, commencing at the given age, and continuing till death; or,* in other words, the value of an annuity of L. 1 upon a single life †.

The numbers in this column are found exactly in the same manner as the numbers in column 7. of Table III. of all the Schemes, except that the contributions in Table VII. do not cease at 70, but continue during life.

In column 3. are shewn the values, at any age above 20, of an annual contribution of L. 1, commencing at the given age, and continuing during the period that two married persons of the same age are both alive, and ceasing when either of them dies; or, in other words, the value of an annuity of L. 1, on two joint lives of the same age †.

The numbers in this column are found in the same manner as those in column 2., except that the squares of the numbers in the Mortality Table, are used instead of the numbers themselves ‡.

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* See Note at Art. 32.

† These two columns differ from common Life Annuity Tables, in being calculated from the middle of the *year of age*, and being increased by unity. In comparing them, then, with any other similar Tables, we must take the mean betwixt any two numbers in such Tables, and increase it by unity, which will give a near approximation.

‡ See second Note at Art. 26. for the reason of this.

In column 4. are contained the differences of the corresponding values in column 2. and 3.; and, consequently, the values, at any age, of an annuity of L. 1 to a widow; and, in column 5., these sums are increased by a 20th part, in order to make a small allowance for the greater longevity of females.

42. In Table VIII., column 3., are shewn the sums of entry-money to be paid in addition to the annual contribution of L. 1, by a person entering a society at any age from 20 to 70, in order to be entitled to the same allowance to his widow as those who entered at 21. In column 6. are shewn the sums to which the annual contribution is to be increased, in order to compensate for not paying the entry-money; and in column 7. the sums to which the annuity is to be diminished, in order to supersede the necessity of either paying entry-money or increasing the annual contribution.

This Table, then, differs from Table VI. of each of the Schemes in bearing no reference to the values of past contributions, which, in these Tables, express also the values of the entry-money; and in the values of the future distributions in column 5. being the values of the future allowances only in the case of the husband and wife being both alive.

The numbers in the different columns are found by reversing the processes employed to find those in the columns of Tables VI.; for, in this Table, column 7. was first found; whereas in those, column 3. was first found.

III.

THE TABLES.

PRELIMINARY TABLES.

TABLE I.—*MORTALITY TABLE.*

(See Art. 26.)

Exhibiting the Law of Mortality after 20 years of age;

Or, the Number of Persons alive at the beginning of each year, till all are dead, out of 1005, all commencing the 21st year of their age at the same time.

Being an average of the Northampton, Carlisle, and latest Swedish Tables of Mortality.

[*The Columns are numbered* 1, 2, 3, 4, *for the sake of reference.*]

Age.	Number who commence that year of Age.	Number who die in that year of Age.	Number who are alive on an average in that year of Age.	Age.	Number who commence that year of Age.	Number who die in that year of Age.	Number who are alive on an average in that year of Age.	Age.	Number who commence that year of Age.	Number who die in that year of Age.	Number who are alive on an average in that year of Age.
1.	2.	3.	4.	1.	2.	3.	4.	1.	2.	3.	4.
21	1005	10	1000	46	733	13	727	71	324	23	313
22	995	10	990	47	720	13	714	72	301	23	290
23	985	10	980	48	707	13	701	73	278	22	267
24	975	10	970	49	694	13	688	74	256	22	245
25	965	10	960	50	681	13	675	75	234	21	224
26	955	10	950	51	668	14	661	76	213	21	203
27	945	10	940	52	654	14	647	77	192	20	182
28	935	10	930	53	640	14	633	78	172	19	163
29	925	10	920	54	626	14	619	79	153	18	144
30	915	10	910	55	612	15	605	80	135	17	127
31	905	10	900	56	597	15	590	81	118	16	110
32	895	11	890	57	582	15	575	82	102	15	95
33	884	11	879	58	567	15	560	83	87	14	80
34	873	11	868	59	552	16	544	84	73	13	67
35	862	11	857	60	536	16	528	85	60	11	55
36	851	11	846	61	520	16	512	86	49	10	44
37	840	11	835	62	504	17	496	87	39	9	35
38	829	11	824	63	487	17	479	88	30	7	27
39	818	12	812	64	470	18	461	89	23	6	20
40	806	12	800	65	452	19	443	90	17	5	15
41	794	12	788	66	433	20	423	91	12	4	10
42	782	12	776	67	413	21	403	92	8	3	7
43	770	12	764	68	392	22	381	93	5	2	4
44	758	12	752	69	370	23	359	94	3	2	2
45	746	13	740	70	347	23	336	95	1	1	1

TABLE II.

WIDOWS' TABLE.

(Art. 27.)

Exhibiting the number of Widows alive each year, till all are dead, out of 1005 Married Women, all commencing the 21st year of their age at the same time, and of the same age as their Husbands.

(Deduced from the Law of Mortality.)

1.	2.	1.	2.	1.	2.
Age.	Number of Widows alive at that Age.	Age.	Number of Widows alive at that Age.	Age.	Number of Widows alive at that Age.
21	10	46	204	71	216
22	20	47	209	72	207
23	29	48	214	73	197
24	38	49	219	74	186
25	47	50	224	75	174
26	56	51	229	76	162
27	65	52	233	77	149
28	74	53	237	78	136
29	82	54	240	79	124
30	90	55	243	80	112
31	98	56	246	81	98
32	106	57	248	82	86
33	114	58	250	83	74
34	122	59	251	84	63
35	130	60	252	85	52
36	138	61	252	86	42
37	145	62	252	87	34
38	152	63	252	88	26
39	159	64	251	89	20
40	166	65	249	90	15
41	173	66	246	91	10
42	180	67	242	92	7
43	186	68	237	93	4
44	192	69	231	94	2
45	198	70	224	95	1

TABLE III.

SICKNESS TABLE, with reference to an INDIVIDUAL,
(Art. 28.)

Exhibiting the Law of Sickness, from 20 to 70 years of age;

Or, the *Quantum* of Sickness which an Individual, on an average, experiences each year, from 20 to 70 years of age.

(Deduced from the Returns made to the Highland Society of Scotland).

(Shewn in *Weeks* and *decimals* of a Week.)

1.	2.	1.	2.
Age.	Weeks of Sickness at that age.	Age.	Weeks of Sickness at that age.
21	·575	46	1·032
22	·576	47	1·108
23	·578	48	1·186
24	·581	49	1·272
25	·585	50	1·361
26	·590	51	1·451
27	·596	52	1·541
28	·603	53	1·633
29	·611	54	1·726
30	·621	55	1·821
31	·631	56	1·918
32	·641	57	2·018
33	·652	58	2·122
34	·663	59	2.230
35	·675	60	2·346
36	·688	61	2·500
37	·702	62	2·736
38	·718	63	3·100
39	·737	64	3·700
40	·758	65	4·400
41	·784	66	5·400
42	·814	67	6·600
43	·852	68	7·900
44	·902	69	9·300
45	·962	70	10·701
		TOTAL,......	98·197

TABLE IV.

SICKNESS TABLE, with reference to a SOCIETY.

(Art. 29.)

Exhibiting the Law of Sickness, as affected by the Law of Mortality, from 20 to 70 years of age;

Or, the *Quantum* of Sickness which takes place each year from 20 to 70 years of age, among 1005 persons, all commencing the 21st year of their age at the same time; the number of persons decreasing, according to the Law of Mortality, and the quantum of Sickness increasing, according to the Law of Sickness.

(Shewn in *Weeks* and *decimals* of a Week.)

Explanation.—This Table is formed by multiplying the numbers in Column 4th of Table I. by the corresponding numbers in Column 2d of Table III.

1.	2.	1.	2.
Age.	Weeks of Sickness at that age.	Age.	Weeks of Sickness at that age.
21	575·000	46	750·264
22	570·240	47	791·112
23	566·440	48	831·386
24	563·570	49	875·136
25	561·600	50	918·675
26	560·500	51	959·111
27	560·240	52	997·027
28	560·790	53	1033·689
29	562·120	54	1068·394
30	565·110	55	1101·705
31	567·900	56	1131·620
32	570·490	57	1160·350
33	573·108	58	1188·320
34	575·484	59	1213·120
35	578·475	60	1238·688
36	582·048	61	1280·000
37	586·170	62	1357·056
38	591·632	63	1484·900
39	598·444	64	1705·700
40	606·400	65	1949·200
41	617·792	66	2284·200
42	631·664	67	2659·800
43	650·928	68	3009·900
44	678·304	69	3338·700
45	711·880	70	3595·536

SCHEME I.

SICKNESS PROVISION.

SCHEME I.—*SICKNESS PROVISION*

TABLE I.

ANNUAL CONTRIBUTIONS.

(Art. 30.)

Exhibiting the sum, to which an Annual Contribution of £1 from each of 1000 persons, all in the middle of the 21st year of their age, when the Contribution commences, and decreasing in number by the Law of Mortality, will amount, in any given number of years, not exceeding 50, at 4 per cent. Compound Interest.

(Annual Contribution supposed to be made at the middle of each year.)

1.	2.	3.	4.	5.	6.
Year of Scheme.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Contribution.
1	21				£1000·000
2	22	£1000·000	£40·000	£1040·000	990·000
3	23	2030·000	81·200	2111·200	980·000
4	24	3091·200	123.648	3214·848	970·000
5	25	4184·848	167·394	4352·242	960·000
6	26	5312.242	212·490	5524·732	950·000
7	27	6474·732	258·989	6733·721	940·000
8	28	7673·721	306·949	7980·670	930·000
9	29	8910·670	356·426	9267·096	920·000
10	30	10187·096	407·484	10594·580	910·000
11	31	11504·580	460·183	11964·763	900·000
12	32	12864·763	514·591	13379·354	890·000
13	33	14269·354	570·774	14840·128	879·000
14	34	15719·128	628·765	16347·893	868·000
15	35	17215·893	688·636	17904·529	857·000
16	36	18761·529	750·461	19511·990	846·000
17	37	20357·990	814·320	21172·310	835·000
18	38	22007·310	880·292	22887·602	824·000
19	39	23711·602	948·464	24660·066	812·000
20	40	25472·066	1018·883	26490·949	800·000
21	41	27290·949	1091·638	28382·587	788·000
22	42	29170·587	1166·823	30337·410	776·000
23	43	31113·410	1244·537	32357·947	764·000
24	44	33121·947	1324·878	34446·825	752·000
25	45	35198·825	1407·953	36606·778	740·000

SCHEME I.—*SICKNESS PROVISION.*

TABLE I.—*Continued.*

ANNUAL CONTRIBUTIONS.

Explanation.

The numbers in any line of Column 3d are found by adding the numbers in the preceding line of Columns 5th and 6th together.

Those in Column 4th are found by taking the interest at 4 per cent. of the sums in Column 3d, or dividing the corresponding numbers by 25.

Those in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th together.

Those in Column 6th are found by multiplying the corresponding numbers in Column 4th of Table I. of the Preliminary Tables, by £1·000.

1.	2.	3.	4.	5.	6.
Year of Scheme.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Contribution.
26	46	£37346·778	£1493·871	£38840·649	£727·000
27	47	39567·649	1582·706	41150·355	714·000
28	48	41864·355	1674·574	43538·929	701·000
29	49	44239·929	1769·597	46009·526	688·000
30	50	46697·526	1867·901	48565·427	675·000
31	51	49240·427	1969·617	51210·044	661·000
32	52	51871·044	2074·842	53945·886	647·000
33	53	54592·886	2183·715	56776·601	633·000
34	54	57409·601	2296·384	59705·985	619·000
35	55	60324·985	2413·000	62737·985	605·000
36	56	63342·985	2533·719	65876·704	590·000
37	57	66466.704	2658·668	69125·372	575·000
38	58	69700·372	2788·015	72488·387	560.000
39	59	73048·387	2921·936	75970·323	544·000
40	60	76514·323	3060·573	79574·896	528·000
41	61	80102·896	3204·116	83307·012	512·000
42	62	83819·012	3352·760	87171·772	496·000
43	63	87667·772	3506·711	91174·483	479·000
44	64	91653·483	3666·139	95319·622	461·000
45	65	95780·622	3831·225	99611·847	443.000
46	66	100054·847	4002·194	104057·041	423·000
47	67	104480·041	4179·202	108659·243	403·000
48	68	109062·243	4362·490	113424·733	381·000
49	69	113805·733	4552·229	118357·962	359·000
50	70	118716·962	4748·678	123465·640	336·000
51	71	123801·640	4952·066	128753·706	

SCHEME I.—*SICKNESS PROVISION.*

TABLE II.

SINGLE CONTRIBUTIONS.

(Art. 31.)

Exhibiting the sum, to which a Single Contribution of £18117·271 from 1000 persons, all in the middle of the 21st year of their age, will amount, in any number of years, not exceeding 75, at 4 per cent. Compound Interest.

1.	2.	3.	4.	1.	2.	3.	4.
Year of Sch.	Age.	Amount.	Interest.	Year of Sch.	Age.	Amount.	Interest.
1	21	£18117·271	£724·691	21	41	£39697·171	£1587·887
2	22	18841·962	753·678	22	42	41285·058	1651·402
3	23	19595·640	783·826	23	43	42936·460	1717·458
4	24	20379·466	815·178	24	44	44653·918	1786·157
5	25	21194·644	847·786	25	45	46440·075	1857·603
6	26	22042·430	881·697	26	46	48297·678	1931·907
7	27	22924·127	916·965	27	47	50229·585	2009·184
8	28	23841·092	953·644	28	48	52238·769	2089·551
9	29	24794·736	991·789	29	49	54328·320	2173·133
10	30	25786·525	1031·461	30	50	56501·453	2260·058
11	31	26817·986	1072·720	31	51	58761·511	2350·460
12	32	27890·706	1115·628	32	52	61111·971	2444·479
13	33	29006·334	1160·253	33	53	63556·450	2542·258
14	34	30166·587	1206·664	34	54	66098·708	2643·948
15	35	31373·251	1254·930	35	55	68742·656	2749·706
16	36	32628·181	1305·127	36	56	71492·362	2859·695
17	37	33933·308	1357·332	37	57	74352·057	2974·082
18	38	35290·640	1411·626	38	58	77326·139	3093·046
19	39	36702·266	1468·091	39	59	80419·185	3216·767
20	40	38170·357	1526·814	40	60	83635·952	3345·438

SCHEME I.—*SICKNESS PROVISION.*

TABLE II.—*Continued.*

SINGLE CONTRIBUTIONS.

Explanation.

The numbers in any line of Column 3d are found by adding the numbers in the preceding line of Columns 3d and 4th.

Those in Column 4th are found by taking the Interest at 4 per cent., of the sums in Column 3d, or dividing the corresponding numbers in Column 3d by 25.

1. Year of Sch.	2. Age.	3. Amount.	4. Interest.	1. Year of Sch.	2. Age.	3. Amount.	4. Interest.
41	61	£86981·390	£3479·256	57	77	£162914·513	£6516·580
42	62	90460·646	3618·426	58	78	169431·093	6777·244
43	63	94079·072	3763·163	59	79	176208·337	7048.333
44	64	97842·235	3913·689	60	80	183256·670	7330·267
45	65	101755·924	4070·237	61	81	190586·937	7623·478
46	66	105826·161	4233·046	62	82	198210·415	7928·417
47	67	110059·207	4402·369	63	83	206138·832	8245·553
48	68	114461·576	4578·463	64	84	214384·385	8575·375
49	69	119040·039	4761·601	65	85	222959·760	8918·391
50	70	123801·640	4952.066	66	86	231878·151	9275·126
51	71	128753·706		67	87	241153.277	9646·131
				68	88	250799·408	10031·976
*				69	89	260831·384	10433·255
				70	90	271264·639	10850·586
51	71	128753·706	5150·148	71	91	282115·225	11284·609
52	72	133903·854	5356·154	72	92	293399·834	11735·993
53	73	139260·008	5570.401	73	93	305135.827	12205·433
54	74	144830·409	5793·216	74	94	317341·260	12693·651
55	75	150623·625	6024·945	75	95	330034·911	13201·396
56	76	156648·570	6265·943	76	96	343236·307	

* The future part of this Table, though given here, is only applicable to the Schemes II. III. and IV.

SCHEME I.—*SICKNESS PROVISION.*

TABLE III.

VALUE of CONTRIBUTIONS.

(Art. 32.)

Exhibiting the Value, at any age from 20 to 70, of the Future Contributions, after that age, of a Society of 1000 persons, all in the middle of the 21st year of age, when the Contributions commence, and decreasing in number by the Law of Mortality; the Annual Contribution of each being £1 from 20 to 70 years of age, and money improving at 4 per cent. Compound Interest.

1.	2.	3.	4.	5.	6.	7.
Year of Scheme.	Age.	Number Living.	Amount of the Single Contribution.	Amount of the Annual Contribution.	Value of the Future Contributions of the Society.	Value of the Future Contributions of an Individual.
1	21	1000	£18117·271		£18117·271	£18·1173
2	22	990	18841·962	£1040·000	17801·962	17·9818
3	23	980	19595·640	2111·200	17484·440	17·8413
4	24	970	20379·466	3214·848	17164·618	17·6955
5	25	960	21194·644	4352·242	16842·402	17·5442
6	26	950	22042·430	5524·732	16517·698	17·3871
7	27	940	22924·127	6733·721	16190·406	17·2238
8	28	930	23841·092	7980·670	15860·422	17·0542
9	29	920	24794·736	9267·096	15527·640	16·8779
10	30	910	25786·525	10594·580	15191·945	16·6944
11	31	900	26817·986	11964·763	14853·223	16·5036
12	32	890	27890·706	13379·354	14511·352	16·3049
13	33	879	29006·334	14840·128	14166·206	16·1163
14	34	868	30166·587	16347·893	13818·694	15·9202
15	35	857	31373·251	17904·529	13468·722	15·7161
16	36	846	32628·181	19511·990	13116·191	15·5037
17	37	835	33933·308	21172·310	12760·998	15·2826
18	38	824	35290·640	22887·602	12403·038	15·0522
19	39	812	36702·266	24660·066	12042·200	14·8303
20	40	800	38170·357	26490·949	11679·408	14·5993
21	41	788	39697·171	28382·587	11314·584	14·3586
22	42	776	41285·058	30337·410	10947·648	14·1078
23	43	764	42936·460	32357·947	10578·513	13·8462
24	44	752	44653·916	34446·825	10207·093	13·5733
25	45	740	46440·075	36606·778	9833·297	13·2882

SCHEME I.—*SICKNESS PROVISION.*

TABLE III.—*Continued.*

VALUE of CONTRIBUTIONS.

Explanation.

Column 3d is Column 4th of Tab. I. of the Prelim. Tables.
Column 4th is Column 3d of Table II. of Scheme I.
Column 5th is Column 5th of Table I. of Scheme I.
The numbers in Column 6th are found by taking the Difference of the corresponding numbers in Columns 4th and 5th of this Table.
Those in Column 7th are found by dividing the numbers in Column 6th by the corresponding numbers in Column 3d of this Table.

1.	2.	3.	4.	5.	6.	7.
Year of Scheme.	Age.	Number Living.	Amount of the Single Contribution.	Amount of the Annual Contribution.	Value of the Future Contributions of the Society.	Value of the Future Contributions of an Individual.
26	46	727	£48297·678	£38840·649	£9457·029	£13·0083
27	47	714	50229·585	41150·355	9079·230	12·7160
28	48	701	52238·769	43538·929	8699·840	12·4106
29	49	688	54328·320	46009·526	8318·794	12·0913
30	50	675	56501·453	48565·427	7936·026	11·7571
31	51	661	58761·511	51210·044	7551·467	11·4243
32	52	647	61111·971	53945·886	7166·085	11·0759
33	53	633	63556·450	56776·601	6779·849	10·7107
34	54	619	66098·708	59705·985	6392·723	10·3275
35	55	605	68742·656	62737·985	6004·671	9·9251
36	56	590	71492·362	65876·704	5615·658	9·5180
37	57	575	74352·057	69125·372	5226·685	9·0899
38	58	560	77326·139	72488·387	4837·752	8·6388
39	59	544	80419·185	75970·323	4448·862	8·1781
40	60	528	83635·952	79574·896	4061·056	7·6914
41	61	512	86981·390	83307·012	3674·378	7·1765
42	62	496	90460·646	87171·772	3288·874	6·6308
43	63	479	94079·072	91174·483	2904·589	6·0639
44	64	461	97842·235	95319·622	2522·613	5·4720
45	65	443	101755·924	99611·847	2144·077	4·8399
46	66	423	105826·161	104057·041	1769·120	4·1823
47	67	403	110059·207	108659·243	1399·964	3·4739
48	68	381	114461·576	113424·733	1036·843	2·7214
49	69	359	119040·039	118357·962	682·077	1·8999
50	70	336	123801·640	123465·640	336·000	1·0000
51	71		128753·706	128753·706		

SCHEME I.—*SICKNESS PROVISION.*

TABLE IV.

ANNUAL DISTRIBUTION.

(Art. 33.)

Exhibiting the sum, to which an Annual Distribution of £1·029725 for each Week of Sickness among 1000 persons, all in the middle of the 21st year of their age when the distribution commences, and decreasing in numbers by the Law of Mortality, will amount, in any given number of years, not exceeding 50, at 4 per cent. Compound Interest.

(Annual Distribution supposed to be made at the middle of each year.)

1.	2.	3.	4.	5.	6.
Year of Sch.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Distribution.
1	21				£592·092
2	22	£592·092	£23·684	£615·776	587·190
3	23	1202·966	48·118	1251·084	583·277
4	24	1834·361	73·375	1907·736	580·322
5	25	2488·058	99·522	2587·580	578·294
6	26	3165·874	126·635	3292·509	577·161
7	27	3869·670	154·787	4024·457	576·893
8	28	4601·350	184·054	4785·404	577·460
9	29	5362.864	214·514	5577·378	578·829
10	30	6156.207	246·248	6402·455	581·908
11	31	6984·363	279·375	7263·738	584·781
12	32	7848·519	313·941	8162·460	587·448
13	33	8749·908	349·996	9099·904	590·144
14	34	9690·048	387·602	10077·650	592·590
15	35	10670·240	426·810	11097·050	595·670
16	36	11692·720	467·709	12160·429	599·349
17	37	12759·778	510·391	13270·169	603·594
18	38	13873·763	554·950	14428·713	609·218
19	39	15037·931	601·517	15639·448	616·233
20	40	16255·681	650·228	16905·909	624·425
21	41	17530·334	701·213	18231·547	636·156
22	42	18867·703	754·708	19622·411	650·440
23	43	20272·851	810·914	21083·765	670·277
24	44	21754·042	870·162	22624·204	698·467
25	45	23322·671	932·907	24255·578	733·041

SCHEME I.—*SICKNESS PROVISION.*

TABLE IV.—*Continued.*

ANNUAL DISTRIBUTION.

Explanation.

The numbers in Column 3d are found by adding the numbers in the preceding line of Columns 5th and 6th together.

Those in Column 4th are found by taking the Interest at 4 per cent. of the sums in Column 3d, or by dividing the corresponding numbers by 25.

Those in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th together.

Those in Column 6th are found by multiplying the corresponding numbers in Column 2d of Table IV. of Preliminary Tables, by £1·029725.

1.	2.	3.	4.	5.	6.
Year of Sch.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Distribution.
26	46	£24988·619	£999·545	£25988·164	£772·566
27	47	26760·730	1070·429	27831·159	814·628
28	48	28645·787	1145·831	29791·618	856·099
29	49	30647·717	1225·909	31873·626	901·150
30	50	32774·776	1310·991	34085·767	945·983
31	51	35031·750	1401·270	36433·020	987·621
32	52	37420·641	1496·826	38917·467	1026·664
33	53	39944·131	1597·765	41541·896	1064·416
34	54	42606·312	1704·252	44310·564	1100·153
35	55	45410·717	1816·429	47227·146	1134·454
36	56	48361·600	1934·464	50296·064	1165·257
37	57	51461·321	2058·453	53519·774	1194·842
38	58	54714·616	2188·584	56903·200	1223·644
39	59	58126·844	2325·074	60451·918	1249·181
40	60	61701·099	2468·044	64169·143	1275·508
41	61	65444·651	2617·786	68062·437	1318·048
42	62	69380·485	2775·220	72155·705	1397·395
43	63	73553·100	2942·124	76495·224	1529·039
44	64	78024·263	3120·970	81145·233	1756·403
45	65	82901·636	3316·065	86217·701	2007·141
46	66	88224·842	3528·994	91753·836	2352·099
47	67	94105·935	3764·238	97870·173	2738·864
48	68	100609·037	4024·361	104633·398	3099·371
49	69	107732·769	4309·311	112042·080	3437·945
50	70	115480·025	4619·201	120099·226	3702·414
51	71	123801·640	4952·066	128753·706	

SCHEME I.—*SICKNESS PROVISION.*

TABLE V.

PROGRESS OF THE FUND.

(Art. 35.)

Exhibiting the Progress of the Fund (for 50 years) of a Society of 1000 persons all in the middle of the 21st year of age, when the Contributions and Distributions commence, admitting no new members, but decreasing in numbers by the Law of Mortality, contributing each £1 per annum, and distributing to each £1·029725 for each Week of Sickness, according to the Law of Sickness.

1.	2.	3.	4.	5.	6.	7.
Year of Sch.	Age.	Number Living.	Amount of Contribution.	Amount of Distribution.	Balance or Nett Stock of Society.	Individual Stock.
1	21	1000				
2	22	990	£1040·000	£615·776	£424·224	£ ·4285
3	23	980	2111·200	1251·084	860·116	·8777
4	24	970	3214·848	1907·736	1307·112	1·3475
5	25	960	4352·242	2587·580	1764·662	1·8382
6	26	950	5524·732	3292·509	2232·223	2·3497
7	27	940	6733·721	4024·457	2709·264	2·8822
8	28	930	7980·670	4785·404	3195·266	3·4357
9	29	920	9267·096	5577·378	3689·718	4·0106
10	30	910	10594·580	6402·455	4192·125	4·6067
11	31	900	11964·763	7263·738	4701·025	5·2234
12	32	890	13379·354	8162·460	5216·894	5·8617
13	33	879	14840·128	9099·904	5740·224	6·5304
14	34	868	16347·893	10077·650	6270·243	7·2238
15	35	857	17904·529	11097·050	6807·479	7·9433
16	36	846	19511·990	12160·429	7351·561	8·6898
17	37	835	21172·310	13270.169	7902·141	9·4636
18	38	824	22887·602	14428·713	8458·889	10·2656
19	39	812	24660·066	15639·448	9020·618	11·1091
20	40	800	26490·949	16905·909	9585·040	11·9813
21	41	788	28382·587	18231·547	10151·040	12·8820
22	42	776	30337·410	19622·411	10714·999	13·8080
23	43	764	32357·947	21083·765	11274·182	14·7568
24	44	752	34446·825	22624·204	11822·621	15·7216
25	45	740	36606·778	24255·578	12351·200	16·6908

SCHEME I.—*SICKNESS PROVISION.*

TABLE V.—*Continued.*

PROGRESS OF THE FUND.

Explanation.

Column 3d is Column 4th of Tab. I. of the Prelim. Tables.
Column 4th is Column 5th of Table I. of Scheme I.
Column 5th is Column 5th of Table IV of Scheme I.
The numbers in Column 6th are found by taking the difference of the corresponding numbers in Columns 4th and 5th of this Table.
Those in Column 7th are found by dividing the numbers in Column 6th by the corresponding numbers in Column 3d of this Table.

1.	2.	3.	4.	5.	6.	7.
Year of Sch.	Age.	Number Living.	Amount of Contribution.	Amount of Distribution.	Balance or Nett Stock of Society.	Individual Stock.
26	46	727	£38840·649	£25988·164	£12852·4[illegible]5	£17·6788
27	47	714	41150·355	27831·15[illegible]	13319·196	18·6543
28	48	701	43538·929	29791·618	13747·311	19·6110
29	49	688	46009·526	31873·626	14135·900	20·5464
30	50	675	48565·427	34085·767	14479·660	21·4513
31	51	661	51210·044	36433·020	14777·024	22·3556
32	52	647	53945·886	38917·467	15028·419	23·2270
33	53	633	56776·601	41541·886	15234·7[illegible]	24·[illegible]675
34	54	619	59705·985	44319·564	153[illegible]5·4[illegible]	24·[illegible]714
35	55	605	62737·985	4722[illegible]·14[illegible]	15510·[illegible]	[illegible]5·637[illegible]
36	56	590	65876·704	502[illegible]	155[illegible]·64	26·437[illegible]
37	57	575	69125·372	53515·774	1[illegible]0[illegible]5·[illegible]5	27·14[illegible]
38	58	560	72488·387	56983·2[illegible]	155[illegible]·[illegible]	27·63[illegible]7
39	59	544	75970·323	60451·518	15518·4[illegible]5	28·526[illegible]
40	60	528	79574·856	64169·143	15405·75[illegible]	29·1775
41	61	512	83307·012	68062·437	15244·57[illegible]	29·7746
42	62	496	87171·772	72155·705	15016·067	30·2743
43	63	479	91174·483	76495·224	14679·25[illegible]	30·6456
44	64	461	95319·622	81145·233	14174·38[illegible]	30·7470
45	65	443	99611·847	86217·701	13394·14[illegible]	30·2351
46	66	423	104057·041	91753·836	12303·20[illegible]	29·0856
47	67	403	108659·243	97870·173	10789·07[illegible]	26·7719
48	68	381	113424·733	104633·398	8791·33[illegible]	23·0743
49	69	359	118357·962	112042·080	6315·88[illegible]	17·5930
50	70	336	123465·640	120099·226	3366·414	10·0191
51	71		128753·706	128753·706		

SCHEME I.—*SICKNESS PROVISION.*

TABLE VI.

Value of Contributions and Distributions, and Increase and Diminution of Annual *Contribution and Distribution.*

(Art. 36.)

Exhibiting, for any given Age from 20 to 70,—

The Individual Stock, or the VALUE of Individual past Contributions;
The Value of Individual future Contributions;
The Value of Individual future Distributions;
The Increase of Annual Contribution to compensate for past Contributions;
And the Diminution of Distribution to supersede the Increase of Future Contributions;

The Annual Contribution from 20 to 70 being £1, and the Distribution being £1·029725 for each Week of Sickness.

1.	2.	3.	4.	5.	6.	7.
Year of Scheme.	Age.	Value of Past Contributions.	Value of Future Contrib.	Value of Future Distrib.	Increase of Annual Contrib.	Diminution of Annual Distrib.
1	21		£18.1173	£18.1173	£1.00000	£1.029725
2	22	£0.4285	17.9818	18.4103	1.02383	1.005758
3	23	0 8777	17.8413	18.7190	1.04919	.981443
4	24	1.3475	17.6955	19.0430	1.07615	.956860
5	25	1.8382	17.5442	19.3824	1.10477	.932067
6	26	2.3497	17.3871	19.7368	1.13514	.907135
7	27	2.8822	17.2238	20.1060	1.16734	.882114
8	28	3.4357	17.0542	20.4899	1.20146	.857063
9	29	4.0106	16.8779	20.8885	1.23762	.832017
10	30	4.6067	16.6944	21.3011	1.27594	.807031
11	31	5 2234	16.5036	21.7270	1.31650	.782168
12	32	5.8617	16.3049	22.1666	1.35950	.757426
13	33	6.5304	16.1163	22.6467	1.40520	.732794
14	34	7.2238	15.9202	23.1440	1.45375	.708323
15	35	7.9433	15.7161	23.6594	1.50542	.684010
16	36	8.6898	15.5037	24.1935	1.56050	.659869
17	37	9·4636	15.2826	24.7462	1.61924	.635931
18	38	10.2656	15.0522	25.3178	1.68200	.612203
19	39	11.1091	14.8303	25.9394	1.74908	.588723
20	40	11.9813	14.5993	26.5806	1.82068	.565573
21	41	12.8820	14.3586	27.2406	1.89709	.542771
22	42	13.8080	14.1078	27.9158	1.97875	.520392
23	43	14.7568	13.8462	28.6030	2.06576	.498471
24	44	15.7216	13.5733	29.2949	2.15827	.477106
25	45	16.6908	13.2882	29.9790	2.25606	.456426

SCHEME I.—*SICKNESS PROVISION.*

TABLE VI.—Continued.

Value of Contributions and Distributions, and Increase and Diminution of Annual *Contribution and Distribution.*

Explanation.

Column 3d is Column 7th of Table V. of Scheme I.

Column 4th is Column 7th of Table III. of Scheme I.

The numbers in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th of this Table.

Those in Column 6th are found by dividing the numbers in Column 5th by the corresponding numbers in Column 4th of this Table.

Those in Column 7th are found by multiplying the numbers in Column 4th by £1.029725, and dividing by the corresponding numbers in Column 5th of this Table.

1.	2.	3.	4.	5.	6.	7.
Years of Scheme.	Age.	Value of Past Contributions.	Value of Future Contrib.	Value of Future Distrib.	Increase of Annual Contrib.	Diminution of Annual Distrib.
26	46	£17.6788	£13.0083	£30.6871	£2.35904	£.436502
27	47	18.6543	12.7160	31.3703	2.46699	.417401
28	48	19.6110	12.4106	32.0216	2.58018	.399090
29	49	20.5464	12.0913	32.6377	2.69927	.381482
30	50	21.4513	11.7571	33.2084	2.82454	.364564
31	51	22.3556	11.4243	33.7799	2.95685	.348251
32	52	23.2279	11.0759	34.3038	3.09716	.332474
33	53	24.0675	10.7107	34.7782	3.24705	.317126
34	54	24.8714	10.3275	35.1989	3.40827	.302125
35	55	25.6378	9.9251	35.5629	3.58313	.287382
36	56	26.4079	9.5180	35.9259	3.77452	.272809
37	57	27.1401	9.0899	36.2300	3.98574	.258352
38	58	27.8307	8.6388	36.4695	4.22159	.243918
39	59	28.5265	8.1781	36.7046	4.48816	.229432
40	60	29.1775	7.6914	36.8689	4.79352	.214816
41	61	29.7746	7.1765	36.9511	5.14890	.199989
42	62	30.2743	6.6308	36.9051	5.56571	.185012
43	63	30.6456	6.0639	36.7095	6.05378	.170096
44	64	30.7470	5.4720	36.2190	6.61897	.155572
45	65	30.2351	4.8399	35.0750	7.24705	.142089
46	66	29.0856	4.1823	33.2679	7.95445	.129453
47	67	26.7719	3.4739	30.2458	8.70658	.118270
48	68	23.0743	2.7214	25.7957	9.47883	.108634
49	69	17.5930	1.8999	19.4929	10.25995	.100363
50	70	10.0191	1.0000	11.0191	11.01910	.093449

SCHEME II.

ANNUITY FOR OLD AGE.

Tables I. II. and III. of Scheme II. are the same as the corresponding Tables of Scheme I. and therefore are not repeated.

SCHEME II.—*ANNUITY FOR OLD AGE.*

TABLE IV.—*ANNUAL DISTRIBUTION.*

(Arts. 37. & 33.)

Exhibiting the sum, to which an Annual Distribution of £58·01095 ℔ an. to each of 313 persons (the number remaining after 50 years, of a Society of 1000, admitting no new members), all in the middle of the 71st year of their age when the Distribution commences, and decreasing in number by the Law of Mortality, will amount, in any given number of years, not exceeding 25, at 4 ℔ cent. Compound Interest.

(Annual Distribution supposed to be made at the middle of each year.)

1.	2.	3.	4.	5.	6.
Year of Sch.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Distribution.
1	21	None.	None.	None.	None.
2	22				
3	23				
4	24				
5	25				
6	26				
7	27				
8	28				
9	29				
10	30				
11	31				
12	32				
13	33				
14	34				
15	35				
16	36				
17	37				
18	38				
19	39				
20	40				
21	41				
22	42				
23	43				
24	44				
25	45				
26	46				
27	47				
28	48				
29	49				
30	50				
31	51				
32	52				
33	53				
34	54				
35	55				
36	56				
37	57				
38	58				

SCHEME II.—*ANNUITY FOR OLD AGE.*

TABLE IV.—*Continued.*

Explanation.

The numbers in Column 3d are found by adding the numbers in the preceding line of Columns 5th and 6th together.

Those in Column 4th are found by taking the Interest at 4 per cent. of the sums in Column 3d, or by dividing the corresponding numbers in Column 3d by 25.

Those in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th together.

Those in Column 6th after the age of 70, are found by multiplying the corresponding numbers in Column 4th of Table I. of the Preliminary Tables, by £58·01095.

1.	2.	3.	4.	5.	6.
Year of Sch.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Distribution.
39	59				
40	60				
41	61				
42	62				
43	63				
44	64				
45	65				
46	66				
47	67				
48	68				
49	69				
50	70				
51	71				£18157·429
52	72	£18157·429	£726·297	£18883·726	16823·177
53	73	35706·903	1428·276	37135·179	15488·925
54	74	52624·104	2104·964	54729·068	14212·684
55	75	68941·752	2757·670	71699·422	12994·454
56	76	84693·876	3387·755	88081·631	11776·224
57	77	99857·855	3994·314	103852·169	10557·994
58	78	114410·163	4576·407	118986·570	9455·785
59	79	128442·355	5137·694	133580·049	8353·578
60	80	141933·627	5677·345	147610·972	7367·391
61	81	154978·363	6199·135	161177·498	6381·205
62	82	167558·703	6702·348	174261·051	5511·041
63	83	179772·092	7190·884	186962·976	4640·876
64	84	191603·852	7664·154	199268·006	3886·734
65	85	203154·740	8126·190	211280·930	3190·602
66	86	214471·532	8578·861	223050·393	2552·482
67	87	225602·875	9024·115	234626·990	2030·384
68	88	236657·374	9466·295	246123·669	1566·296
69	89	247689·965	9907·598	257597·563	1160·219
70	90	258757·782	10350·311	269108·093	870·165
71	91	269978·258	10799·130	280777·388	580·110
72	92	281357·498	11254·300	292611·798	406·676
73	93	293017·874	11720·715	304738·589	232·044
74	94	304970·633	12198·826	317169·459	116·022
75	95	317285·481	12691·419	329976·900	58·011
76		330034·911	13201·396	343236·307	

SCHEME II.—*ANNUITY FOR OLD AGE.*

TABLE V.—*PROGRESS OF THE FUND.*

(Arts. 38. & 35.)

Exhibiting the Progress of the Fund (for 75 years) of a Society of 1000 persons all in the middle of the 21st year of age, when the Contributions commence, admitting no new members, but decreasing in number by the Law of Mortality, contributing each £1 per annum for the first 50 years, and distributing to each £58·01095 per annum for the other 25 years.

1.	2.	3.	4.	5.	6.	7.
Year of Sch.	Age.	Number Living.	Amount of Contribution.	Amount of Distribution.	Balance or Nett Stock of Society.	Individual Stock.
1	21	1000		None.		
2	22	990	£1040·000		£1040·000	£1·0505
3	23	980	2111·200		2111·200	2·1543
4	24	970	3214·848		3214·848	3·3143
5	25	960	4352·242		4352·242	4·5336
6	26	950	5524·732		5524·732	5·8155
7	27	940	6733·721		6733·721	7·1635
8	28	930	7980·670		7980·670	8·5814
9	29	920	9267·096		9267·096	10·0729
10	30	910	10594·580		10594·580	11·6424
11	31	900	11964·763		11964·763	13·2942
12	32	890	13379·354		13379·354	15·0330
13	33	879	14840·128		14840·128	16·8830
14	34	868	16347·893		16347·893	18·8340
15	35	857	17904·529		17904·529	20·8921
16	36	846	19511·990		19511·990	23·0638
17	37	835	21172·310		21172·310	25·3561
18	38	824	22887·602		22887·602	27·7762
19	39	812	24660·066		24660·066	30·3695
20	40	800	26490·949		26490·949	33·1137
21	41	788	28382·587		28382·587	36·0185
22	42	776	30337·410		30337·410	39·0946
23	43	764	32357·947		32357·947	42·3533
24	44	752	34446·825		34446·825	45·8069
25	45	740	36606·778		36606·778	49·4686
26	46	727	38840·649		38840·649	53·4259
27	47	714	41150·355		41150·355	57·6336
28	48	701	43538·929		43538·929	62·1097
29	49	688	46009·526		46009·526	66·8743
30	50	675	48565·427		48565·427	71·9488
31	51	661	51210·044		51210·044	77·4736
32	52	647	53945·886		53945·886	83·3785
33	53	633	56776·601		56776·601	89·6945
34	54	619	59705·985		59705·985	96·4555
35	55	605	62737·985		62737·985	103·6901
36	56	590	65876·704		65876·704	111·6554
37	57	755	69125·372		69125·372	120·2180
38	58	560	72488·387		72488·387	129·4435

SCHEME II.—*ANNUITY FOR OLD AGE.*

TABLE V.—*Continued.*

Explanation.

Column 3d is Column 4th of Table I. of the Preliminary Tables.
Column 4th is Column 5th of Table I. of Scheme II. till the age of 71, and Column 3d of Table II. of Scheme II. after that age.
Column 5th is Column 5th of Table IV. of Scheme II.
The numbers in Column 6th are found by taking the Difference of the corresponding numbers in Columns 4th and 5th of this Table.
Those in Column 7th are found by dividing the numbers in Column 6th by the corresponding numbers in Column 3d of this Table.

1.	2.	3.	4.	5.	6.	7.
Year of Sch.	Age.	Number Living.	Amount of Contribution.	Amount of Distribution.	Balance or Nett Stock of Society.	Individual Stock.
39	59	544	£75970·323		£75970·323	£139·6513
40	60	528	79574·896		79574·896	150·7100
41	61	512	83307·012		83307·012	162·7090
42	62	496	87171·772		87171·772	175·7495
43	63	479	91174·483		91174·483	190·3434
44	64	461	95319·622		95319·622	206·7671
45	65	443	99611·847		99611·847	224·8574
46	66	423	104057·041		104057·041	245·9977
47	67	403	108659·243		108659·243	269·6259
48	68	381	113424·733		113424·733	297·7027
49	69	359	118357·962		118357·962	329·6879
50	70	336	123465·640		123465·640	367·4573
51	71	313	128753·706		128753·706	411·3537
52	72	290	133903·854	£18883·726	115020·128	396·6211
53	73	267	139260·008	37135·179	102124·829	382·4900
54	74	245	144830·409	54729·068	90101·341	367·7606
55	75	224	150623·625	71699·422	78924·203	352·3402
56	76	203	156648·570	88081·631	68566·939	337·7682
57	77	182	162914·513	103852·169	59062·344	324·5184
58	78	163	169431·093	118986·570	50444·523	309·4756
59	79	144	176208·337	133580·049	42628·288	296·0298
60	80	127	183256·670	147610·972	35645·698	280·6748
61	81	110	190586·937	161177·498	29409·439	267·3585
62	82	95	198210·415	174261·051	23949·364	252·0985
63	83	80	206138·832	186962·976	19175·856	239·6982
64	84	67	214384·385	199268·006	15116·379	225·6176
65	85	55	222959·760	211280·930	11678·830	212·3424
66	86	44	231878·151	223050·393	8827·758	200·6309
67	87	35	241153.277	234626·990	6526·287	185·3225
68	88	27	250799·408	246123·669	4675·739	173·1755
69	89	20	260831·384	257597·563	3233·821	161·6910
70	90	15	271264·639	269108·093	2156·546	143·7697
71	91	10	282115·225	280777·388	1337·837	133·7837
72	92	7	293399·834	292611·798	788·036	112·5766
73	93	4	305135.827	304738·589	397·238	99·3095
74	94	2	317341·260	317169·459	171·801	85·9005
75	95	1	330034·911	329976·900	58·011	58·0110
76	96		343236·307	343236·307		

SCHEME II.—*ANNUITY FOR OLD AGE.*

TABLE VI.

Values of Contributions and Distributions, and Increase and Diminution of Annual *Contribution and Distribution.*

(Arts. 39. & 36.)

Exhibiting, for any given Age from 20 to 70,—
The Individual Stock, or the VALUE of Individual past Contributions;
The Value of Individual future Contributions;
The Value of Individual future Distributions;
The Increase of Annual Contribution to compensate for past Contributions;
And the Diminution of Distribution to supersede the Increase of Future Contributions;

The Annual Contribution from 20 to 70 being £1, and the Annual Distribution after that Age being £58.01095 for each Individual.

1.	2.	3.	4.	5.	6.	7.
Year of Scheme.	Age.	Value of Past Contributions.	Value of Future Contrib.	Value of Future Distrib.	Increase of Annual Contrib.	Diminution of Annual Distrib.
1	21		£18.1173	£18·1173	£1·00000	£58·01095
2	22	£1.0505	17.9818	19·0323	1·05842	54·8090
3	23	2.1543	17.8413	19·9956	1·12075	51·7609
4	24	3.3143	17.6955	21·0098	1·18730	48·8597
5	25	4.5336	17.5442	22·0778	1·25841	46·0986
6	26	5.8155	17.3871	23·2026	1·33447	43·4711
7	27	7.1635	17.2238	24·3873	1·41591	40·9709
8	28	8.5814	17.0542	25·6356	1·50318	38·5921
9	29	10.0729	16.8779	26·9508	1·59681	36·3293
10	30	11.6424	16.6944	28·3368	1·69738	34·1767
11	31	13.2942	16.5036	29·7978	1·80553	32·1295
12	32	15.0330	16.3049	31·3379	1·92199	30·1827
13	33	16.8830	16.1163	32·9993	2·04757	28·3316
14	34	18.8340	15.9202	34·7542	2·18302	26·5736
15	35	20.8921	15.7161	36·6082	2·32934	24·9044
16	36	23.0638	15.5037	38·5675	2·48763	23·3197
17	37	25.3561	15.2826	40·6387	2·65915	21·8156
18	38	27.7762	15.0522	42·8284	2·84532	20·3882
19	39	30.3695	14.8303	45·1998	3·04780	19·0337
20	40	33.1137	14.5993	47·7130	3·26817	17·7503
21	41	36.0185	14.3586	50·3771	3·50850	16·5344
22	42	39.0946	14.1078	53·2024	3·77113	15·3829
23	43	42.3533	13.8462	56·1995	4·05884	14·2925
24	44	45.8069	13.5733	59·3802	4·37476	13·2603
25	45	49.4686	13.2882	62·7568	4·72275	12·2833

SCHEME II.—*ANNUITY FOR OLD AGE.*

TABLE VI.—Continued.

Values of Contributions and Distributions, and Increase and Diminution of Annual *Contribution and Distribution.*

Explanation.

Column 3d is Column 7th of Table V. of Scheme II.
Column 4th is Column 7th of Table III. of Scheme II.
The numbers in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th of this Table.
Those in Column 6th are found by dividing the numbers in Column 5th by the corresponding numbers in Column 4th of this Table.
Those in Column 7th are found by multiplying the numbers in Column 4th by £58.01095, and dividing by the corresponding numbers in Column 5th of this Table.

1.	2.	3.	4.	5.	6.	7.
Year of Scheme.	Age.	Value of Past Contributions.	Value of Future Contrib.	Value of Future Distrib.	Increase of Annual Contrib.	Diminution of Annual Distrib.
26	46	£53·4259	£13·0083	£66·4342	£5·10706	£11·3590
27	47	57·6335	12·7160	70·3495	5·53236	10·4857
28	48	62·1097	12·4106	74·5203	6·00457	9·66113
29	49	66·8743	12·0913	78·9656	6·53078	8·88270
30	50	71 9488	11·7571	83·7059	7·11960	8·14806
31	51	77·4736	11·4243	88·8979	7·78147	7·45501
32	52	83·3785	11·0759	94·4544	8·52792	6·80248
33	53	89·6945	10·7107	100·4052	9·37429	6·18831
34	54	96·4555	10·3275	106·7830	10·3397	5·61052
35	55	103·6991	9·9251	113·6242	11·4482	5·06727
36	56	111·6554	9·5180	121·1734	12·7310	4·55668
37	57	120·2180	9 0899	129·3079	14·2254	4·07797
38	58	129·4435	8·6388	138·0823	15·9840	3·62932
39	59	139·6513	8·1781	147·8294	18 0763	3 20924
40	60	150·7100	7·6914	158·4014	20·5946	2·81680
41	61	162·7090	7·1765	169·8855	23·6725	2·45057
42	62	175·7495	6·6308	182·3803	27·5050	2·10910
43	63	190·3434	6·0639	196·4073	32·3896	1·76104
44	64	206·7671	5·4720	212·2391	38·7864	1·49565
45	65	224·8574	4·8399	229·6973	47·4591	1·222336
46	66	245·9977	4·1823	250·1800	59·8188	·969779
47	67	269·6259	3·4739	273·0998	78·6148	·737914
48	68	297·7027	2·7214	300·4241	110·3932	·525494
49	69	329·6879	1·8999	331·5878	174·5290	·332385
50	70	367·4573	1·0000	368·4573	368·4573	·157443

SCHEME III.

FUNERAL ALLOWANCE.

Tables I. II. and III. of Scheme III. are the same as the corresponding Tables of Scheme I., and therefore are not repeated.

SCHEME III.—*FUNERAL ALLOWANCE.*

TABLE IV.—*ANNUAL DISTRIBUTION.*

(Arts. 37. & 33.)

Exhibiting the sum, to which an Annual Distribution of £59·9584205 for each death that takes place in a Society of 1000 persons, all in the middle of the 21st year of their age when the Distribution commences, and decreasing in numbers by the Law of Mortality, will amount, in any given number of years, not exceeding 75, at 4 per cent. Compound Interest.

(Annual Distribution supposed to be made at the middle of each year.)

1.	2.	3.	4.	5.	6.
Year of Sch.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Distribution.
1	21				£599·584
2	22	£599·584	£23·983	£623·567	599·584
3	23	1223·151	48·926	1272·077	599·585
4	24	1871·662	74·867	1946·529	599·584
5	25	2546·113	101·844	2647·957	599·584
6	26	3247·541	129·902	3377·443	599·584
7	27	3977·027	159·081	4136·103	599·585
8	28	4735·693	189·428	4925·121	599·584
9	29	5524·705	220·988	5745·693	599·584
10	30	6345·277	253·811	6599·088	599·584
11	31	7198·672	287·947	7486·619	599·584
12	32	8086·203	323·448	8409·651	659·543
13	33	9069·194	362·768	9431·962	659·543
14	34	10091·505	403·660	10495·165	659·542
15	35	11154·707	446·188	11600·895	659·543
16	36	12260·438	490·418	12750·856	659·542
17	37	13410·398	536·416	13946·814	659·543
18	38	14606·357	584·254	15190·611	659·543
19	39	15850·154	634·006	16484·160	719·501
20	40	17203·661	688·146	17891·807	719·501
21	41	18611·308	744·453	19355·761	719·501
22	42	20075·262	803·010	20878·272	719·501
23	43	21597·773	863·911	22461·684	719·501
24	44	23181·185	927·248	24108·433	719·501
25	45	24827·934	993·117	25821·051	779·460
26	46	26600·511	1064·020	27664·531	779·459
27	47	28443·990	1137·760	29581·750	779·460
28	48	30361·210	1214·448	31575·658	779·459
29	49	32355·117	1294·205	33649·322	779·460
30	50	34428·782	1377·151	35805·933	779·459
31	51	36585·392	1463·416	38048·808	839·418
32	52	38888·226	1555·529	40443·755	839·418
33	53	41283·173	1651·327	42934·500	839·418
34	54	43773·918	1750·957	45524·875	839·417
35	55	46364·292	1854·572	48218·864	899·376
36	56	49118·240	1964·730	51082·970	899·376
37	57	51982·346	2079·294	54061·640	899·376
38	58	54961·016	2198·441	57159·457	899·376

SCHEME III.—*FUNERAL ALLOWANCE.*

TABLE IV.—*Continued.*

Explanation.

The numbers in Column 3d are found by adding the numbers in the preceding line of Columns 5th and 6th together.

Those in Column 4th are found by taking the Interest at 4 per cent. of the sums in Column 3d, or by dividing the corresponding numbers in Column 3d by 25.

Those in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th together.

Those in Column 6th are found by multiplying the corresponding numbers in Column 3d of Table I. of the Prelim. Tables, by £59·95842.

1. Year of Sch.	2. Age.	3. Amount without Interest.	4. Interest.	5. Amount with Interest.	6. Annual Distribution.
39	59	58058·833	£2322·353	£60381·186	£959.335
40	60	61340·521	2453·621	63794·142	959·335
41	61	64753·477	2590·139	67343·616	959·335
42	62	68302·951	2732·118	71035·069	1019·293
43	63	72054·362	2882·174	74936·536	1019·293
44	64	75955·829	3038·233	78994·062	1079·252
45	65	80073·314	3202·933	83276·247	1139·210
46	66	84415·457	3376·618	87792·075	1199·168
47	67	88991·243	3559·650	92550·893	1259·127
48	68	93810·020	3752·401	97562·421	1319·085
49	69	98881·506	3955·260	102836·766	1379·044
50	70	104215·810	4168·632	108384·442	1379·044
51	71	109763·486	4390·539	114154·025	1379·044
52	72	115533·069	4621·323	120154·392	1379·043
53	73	121533·435	4861·338	126394·773	1319·085
54	74	127713·858	5108·555	132822·413	1319·085
55	75	134141·498	5365·660	139507·158	1259·127
56	76	140766·285	5630·651	146396·936	1259·127
57	77	147656·063	5906·243	153562·306	1199·168
58	78	154761·474	6190·459	160951·933	1139·210
59	79	162091·143	6483·645	168574·788	1079·252
60	80	169654·040	6786·162	176440·202	1019·293
61	81	177459·495	7098·380	184557·875	959·335
62	82	185517·210	7420·688	192937·898	899·376
63	83	193837·274	7753·491	201590·765	839·418
64	84	202430·183	8097·207	210527·390	779·459
65	85	211306·849	8452·274	219759·123	659·543
66	86	220418·666	8816·747	229235·413	599·584
67	87	229834·997	9193·400	239028·397	539·626
68	88	239568·023	9582·721	249150·744	419·709
69	89	249570·453	9982·818	259553·271	359·750
70	90	259913·021	10396·521	270309·542	299·792
71	91	270609·334	10824·373	281433·707	239·834
72	92	281673·541	11266·942	292940·483	179·875
73	93	293120·358	11724·814	304845·172	119·917
74	94	304965·089	12198·603	317163·692	119·917
75	95	317283·609	12691·344	329974·953	59·958
76		330034·911	13201·396	343236·307	

SCHEME III.—*FUNERAL ALLOWANCE.*

TABLE V.—*PROGRESS OF THE FUND.*

(Arts. 38. & 35.)

Exhibiting the Progress of the Fund (for 75 years) of a Society of 1000 persons all in the middle of the 21st year of age, when the Contributions and Distributions commence, admitting no new members, but decreasing in number by the Law of Mortality, contributing each £1 per annum for the first 50 years, and distributing £59·9584205 for each Death, till all are dead.

(Annual Distribution supposed to be made at the middle of each year.)

1.	2.	3.	4.	5.	6.	7.
Year of Sch.	Age.	Number Living.	Amount of Contribution.	Amount of Distribution.	Balance or Nett Stock of Society.	Individual Stock.
1	21	1000				
2	22	990	£1040·000	£623·567	£416·433	£ ·4206
3	23	980	2111·200	1272·077	839·123	·8562
4	24	970	3214·848	1946·529	1268·319	1·3075
5	25	960	4352·242	2647·957	1704·285	1·7753
6	26	950	5524·732	3377·443	2147·289	2·2603
7	27	940	6733·721	4136·108	2597·613	2·7634
8	28	930	7980·670	4925·121	3055·549	3·2855
9	29	920	9267·096	5745·693	3521·403	3·8276
10	30	910	10594·580	6599·088	3995·492	4·3906
11	31	900	11964·763	7486·619	4478·144	4·9757
12	32	890	13379·354	8409·651	4969·703	5·5839
13	33	879	14840·128	9431·962	5408·166	6·1526
14	34	868	16347·893	10495·165	5852·728	6·7428
15	35	857	17904·529	11600·895	6303·634	7·3555
16	36	846	19511·990	12750·856	6761·134	7·9919
17	37	835	21172·310	13946·814	7225·496	8·6533
18	38	824	22887·602	15190·611	7696·991	9·3410
19	39	812	24660·066	16484·160	8175·906	10·0688
20	40	800	26490·949	17891·807	8599·142	10·7489
21	41	788	28382·587	19355·761	9026·826	11·4554
22	42	776	30337·410	20878·272	9459·138	12·1896
23	43	764	32357·947	22461·684	9896·263	12·9532
24	44	752	34446·825	24108·433	10338·392	13·7479
25	45	740	36606·778	25821·051	10785·727	14·5753
26	46	727	38840·649	27664·531	11176·118	15·3729
27	47	714	41150·355	29851·750	11568·605	16·2025
28	48	701	43538·929	31575·658	11963·271	17·0660
29	49	688	46009·526	33649·322	12360·204	17·9654
30	50	675	48565·427	35805·933	12759·494	18·9029
31	51	661	51210·044	38048·808	13161·236	19·9111
32	52	647	53945·886	40443·755	13502·131	20·8688
33	53	633	56776·601	42934·500	13842·101	21·8675
34	54	619	59705·985	45524·875	14181·110	22·9097
35	55	605	62737·985	48218·864	14519·121	23·9985
36	56	590	65876·704	51082·970	14793·734	25·0741
37	57	575	69125·372	54061·640	15063·732	26·1978
38	58	560	72488·387	57159·457	15328·930	27·3731

SCHEME III.—*FUNERAL ALLOWANCE.*

TABLE V.—*Continued.*

Explanation.

Column 3d is Column 4th of Table I. of the Preliminary Tables.
Column 4th is Column 5th of Table I. of Scheme III. till the age of 71, and Column 3d of Table II. of Scheme III. after that age.
Column 5th is Column 5th of Table IV. of Scheme III.
The numbers in Column 6th are found by taking the Difference of the corresponding numbers in Columns 4th and 5th of this Table.
Those in Column 7th are found by dividing the numbers in Column 6th by the corresponding numbers in Column 3d of this Table.

1.	2.	3.	4.	5.	6.	7.
Year of Sch.	Age.	Number Living.	Amount of Contribution.	Amount of Distribution.	Balance or Nett Stock of Society.	Individual Stock.
39	59	544	£75970·323	£60381·186	£15589·137	£28·6565
40	60	528	79574·896	63794·142	15780·754	29·8878
41	61	512	83307·012	67343·616	15963·396	31·1785
42	62	496	87171·772	71035·069	16136·793	32·5337
43	63	479	91174·483	74936·536	16237·947	33·8997
44	64	461	95319 622	78994·062	16325·560	35·4134
45	65	443	99611·847	83276·247	16335·600	36·8750
46	66	423	104057·041	87792·075	16264·966	38·4515
47	67	403	108659·243	92550·893	16108·350	39·9711
48	68	381	113424·733	97562·421	15862·312	41·6333
49	69	359	118357·962	102836·766	15521·196	43·2345
50	70	336	123465·640	108384·442	15081·198	44·8845
51	71	313	128753·706	114154·025	14599·681	46·6443
52	72	290	133903·854	120154·392	13749·462	47·4119
53	73	267	139260·008	126394·773	12865·235	48·1844
54	74	245	144830·409	132822·413	12007·996	49·0122
55	75	224	150623·625	139507·158	11116·467	49·6271
56	76	203	156648·570	146396·936	10251·634	50·5007
57	77	182	162914·513	153562·306	9352·207	51·3858
58	78	163	169431·093	160951·933	8479·160	52·0194
59	79	144	176208·337	168574·788	7633·549	53·0108
60	80	127	183256·670	176440·202	6816·468	53·6730
61	81	110	190586·937	184557·875	6029·062	54·8097
62	82	95	198210·415	192937·898	5272·517	55·5002
63	83	80	206138·832	201590·765	4548·067	56·8508
64	84	67	214384·385	210537·390	3856·995	57·5671
65	85	55	222959·760	219757·123	3200·637	58·1934
66	86	44	231878·151	229235·413	2642·738	60·0622
67	87	35	241153·277	239028·397	2124·880	60·7109
68	88	27	250799·408	249150·744	1648·664	61·0616
69	89	20	260831·384	259553·271	1278·113	63·9056
70	90	15	271264·639	270309·542	955·097	63·6731
71	91	10	282115·225	281433·707	681·518	68·1518
72	92	7	293399·834	292940·483	459·351	65·6216
73	93	4	305135·827	304845·172	290·655	72·6637
74	94	2	317341·260	317163·692	177·568	88·7840
75	95	1	330034·911	329974·953	59·958	59·9580
76			343236·307	343236·307		

SCHEME III.—*FUNERAL ALLOWANCE.*

TABLE VI.

Values of Contributions and Distributions, and Increase and Diminution of Annual *Contribution and Distribution.*

(Arts. 39. & 36.)

Exhibiting, for any given Age from 20 to 70,—
The Individual Stock, or the VALUE of Individual past Contributions;
The Value of Individual future Contributions;
The Value of Individual future Distributions;
The Increase of Annual Contribution to compensate for past Contributions;
And the Diminution of Distribution to supersede the Increase of Future Contributions;

The Annual Contribution from 20 to 70 being £1, and Distribution being £59.95842 for each Death.

1.	2.	3.	4.	5.	6.	7.
Year of Scheme.	Age.	Value of Past Contributions.	Value of Future Contrib.	Value of Future Distrib.	Increase of Annual Contrib.	Diminution of the Distrib.
1	21		£18.1173	£18·1173	£1·00000	£59·95842
2	22	£0·4206	17.9818	18·4024	1·02339	58·5880
3	23	0·8562	17.8413	18·6975	1·04799	57·2128
4	24	1·3075	17.6955	19·0030	1·07389	55·8330
5	25	1·7753	17.5442	19·3195	1·10119	54·4487
6	26	2·2603	17.3871	19·6474	1·13000	53·0606
7	27	2·7634	17.2238	19·9872	1·16044	51·6687
8	28	3·2855	17.0542	20·3397	1·19265	50·2732
9	29	3·8276	16.8779	20·7055	1·22678	48·8746
10	30	4·3906	16.6944	21·0850	1·26300	47·4731
11	31	4·9757	16.5036	21·4793	1·30149	46·0690
12	32	5·5839	16.3049	21·8888	1·34247	44·6628
13	33	6·1526	16.1163	22·2689	1·38176	43·3927
14	34	6·7428	15.9202	22·6630	1·42354	42·1193
15	35	7·3555	15.7161	23·0716	1·46802	40·8430
16	36	7·9919	15.5037	23·4956	1·51548	39·5639
17	37	8·6533	15.2826	23·9359	1·56622	38·2823
18	38	9·3410	15.0522	24·3932	1·62057	36·9983
19	39	10·0688	14.8303	24·8991	1·67893	35·7122
20	40	10·7489	14.5993	25·3482	1·73626	34·5331
21	41	11·4554	14.3586	25·8140	1·79781	33·3508
22	42	12·1896	14.1078	26·2974	1·86403	32·1660
23	43	12·9532	13.8462	26·7994	1·93550	30·9781
24	44	13·7479	13.5733	27·3212	2·01286	29·7876
25	45	14·5753	13.2882	27·8635	2·09686	28·5944

SCHEME III.—*FUNERAL ALLOWANCE.*

TABLE VI.—Continued.

Values of Contributions and Distributions, and Increase and Diminution of Annual *Contribution and Distribution.*

Explanation.

Column 3d is Column 7th of Table V. of Scheme III.
Column 4th is Column 7th of Table III. of Scheme III.
The numbers in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th of this Table.
Those in Column 6th are found by dividing the numbers in Column 5th by the corresponding numbers in Column 4th of this Table.
Those in Column 7th are found by multiplying the numbers in Column 4th by £59.95842, and dividing the corresponding numbers in Column 5th of this Table.

1. Year of Scheme.	2. Age.	3. Value of Past Contributions.	4. Value of Future Contrib.	5. Value of Annual Distrib.	6. Increase of Annual Contrib.	7. Diminution of the Distrib.
26	46	£15·3729	£13·0083	£28·3812	£2·18178	£27·4815
27	47	16·2025	12·7160	28·9185	2·27418	26·3648
28	48	17·0660	12·4106	29·4766	2·37511	25·2444
29	49	17·9654	12·0913	30·0567	2·48581	24·1202
30	50	18·9029	11·7571	30·6600	2·60779	22·9920
31	51	19·9111	11·4243	31·3354	2·74287	21.8597
32	52	20·8688	11·0759	31·9447	2·88416	20·7888
33	53	21·8675	10·7107	32·5782	3·04165	19·7125
34	54	22·9097	10·3275	33·2372	3·21832	18·6303
35	55	23·9985	9·9251	33·9236	3·41796	17·5422
36	56	25·0741	9·5180	34·5921	3·63439	16·4975
37	57	26·1978	9·0899	35·2877	3·88208	15·4449
38	58	27·3731	8·6388	36·0119	4·16862	14·3833
39	59	28·6565	8·1781	36·8346	4·50405	13·3121
40	60	29·8878	7·6914	37·5792	4·88587	12·2718
41	61	31·1785	7·1765	38·3550	5·34453	11·21865
42	62	32·5337	6·6308	39·1645	5·90645	10·15134
43	63	33·8997	6·0639	39·9636	6·59041	9·09782
44	64	35·4134	5·4720	40·8854	7·47175	8·02469
45	65	36·8750	4·8399	41·7149	8·61896	6·95657
46	66	38·4515	4·1823	42·6338	10·19286	5·88181
47	67	39·9711	3·4739	43·4450	12·50611	4·79433
48	68	41·6333	2·7214	44·3547	16·29849	3·67877
49	69	43·2345	1·8999	45·1344	23·75620	2·52391
50	70	44·8845	1·0000	45·8845	45·88450	1·30672

SCHEME IV.

WIDOWS' ANNUITY.

Tables I. II. and III. of Scheme IV. are the same as the corresponding Tables of Scheme I. and therefore are not repeated.

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE IV.—*ANNUAL DISTRIBUTION.*

(Arts. 37. & 33.)

Exhibiting the sum, to which an Annual Distribution of £5·6277818 ₩ annum to each Widow that is alive each year till all are dead, out of 1000 Married Women, all in the 21st year of their age, and of the same age as their Husbands, will amount, in any given number of years, not exceeding 75, at 4 per cent. Compound Interest.

(Annual Distribution supposed to be made at the middle of each year.)

1.	2.	3.	4.	5.	6.
Year of Sch.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Distribution.
1	21				£56·278
2	22	£56·278	£2·251	£58·529	112·556
3	23	171·085	6·843	177·928	163·206
4	24	341·134	13·645	354·779	213·856
5	25	568·635	22·745	591·380	264·506
6	26	855·886	34·235	890·121	315·156
7	27	1205·277	48·211	1253·488	365·806
8	28	1619·294	64·772	1684·066	416·456
9	29	2100·522	84·020	2184·542	461·478
10	30	2646·020	105·841	2751·861	506·500
11	31	3258·362	130·334	3388·696	551·523
12	32	3940·219	157·608	4097·827	596·545
13	33	4694·372	187·775	4882·147	641·567
14	34	5523·714	220·949	5744·663	686·589
15	35	6431·252	257·250	6688·502	731·612
16	36	7420·114	296·805	7716·919	776·634
17	37	8493·553	339·742	8833·295	816·028
18	38	9649·323	385·973	10035·296	855·423
19	39	10890·719	435·629	11326·348	894·817
20	40	12221·165	488·846	12710·011	934·212
21	41	13644·223	545·769	14189·992	973·606
22	42	15163·598	606·544	15770·142	1013·001
23	43	16783·143	671·326	17454·469	1046·767
24	44	18501·236	740·050	19241·286	1080·534
25	45	20321·820	812·873	21134·693	1114·301
26	46	22248·994	889·959	23138·953	1148·067
27	47	24287·020	971·481	25258·501	1176·207
28	48	26434·708	1057·388	27492·096	1204·345
29	49	28696·441	1147·858	29844·299	1232·484
30	50	31076·783	1243·072	32319·855	1260·623
31	51	33580·478	1343·219	34923·697	1288·762
32	52	36212·459	1448·498	37660·957	1311·273
33	53	38972·230	1558·890	40531·120	1333·784
34	54	41864·904	1674·596	43539·500	1350·668
35	55	44890·168	1795·607	46685·775	1367·551
36	56	48053·326	1922·133	49975·459	1384·434
37	57	51359·893	2054·396	53414·289	1395·690
38	58	54809·979	2192·399	57002·378	1406·945

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE IV.—*Continued.*

Explanation.

The numbers in Column 3d are found by adding the numbers in the preceding line of Columns 5th and 6th together.

Those in Column 4th are found by taking the Interest at 4 per cent. of the sums in Column 3d, or by dividing the corresponding numbers in Column 3d by 25.

Those in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th together.

Those in Column 6th are found by multiplying the corresponding numbers in Column 2d of Table II. of the Prelim. Tables, by £5·6277818.

1.	2.	3.	4.	5.	6.
Year of Sch.	Age.	Amount without Interest.	Interest.	Amount with Interest.	Annual Distribution.
39	59	£58409·323	£2336·373	£60745·696	£1412·573
40	60	62158·269	2486·331	64644·600	1418·201
41	61	66062·801	2642·512	68705·313	1418·201
42	62	70123·514	2804·941	72928·455	1418·201
43	63	74346·656	2973·866	77320·522	1418·201
44	64	78738·723	3149.549	81888·272	1412·573
45	65	83300·845	3332·034	86632·879	1401·318
46	66	88034·197	3521·368	91555·565	1384·434
47	67	92939·999	3717·600	96657·599	1361·923
48	68	98019·522	3920·781	101940·303	1333·784
49	69	103274·087	4130·964	107405·051	1300·017
50	70	108705·068	4348·203	113053·271	1260·623
51	71	114313·394	4572·556	118886·459	1215·601
52	72	120102·051	4804·082	124906·133	1164·951
53	73	126071·084	5042·843	131113·927	1108·673
54	74	132222·600	5288·904	137511·504	1046·767
55	75	138558·271	5542·331	144100·602	979·234
56	76	145079·836	5803·194	150883·030	911·701
57	77	151794·731	6071·789	157866·520	838·539
58	78	158705·059	6348·202	165053·261	765·378
59	79	165818·639	6632·746	172451·385	697·845
60	80	173149·230	6925·969	180075·199	630·312
61	81	180705·511	7228·221	187933·732	551·522
62	82	188485·254	7539·410	196024·664	483·990
63	83	196508·654	7860·346	204369·000	416·456
64	84	204785·456	8191·418	212976·874	354·550
65	85	213331·424	8533·257	221864·681	292·645
66	86	222157·326	8886·293	231043·619	236·367
67	87	231279·986	9251·199	240531·185	191·345
68	88	240722·530	9628·901	250351·431	146·322
69	89	250497·753	10019·910	260517·663	112·556
70	90	260630·219	10425·209	271055·428	84·417
71	91	271139·845	10845·593	281985·438	56·278
72	92	282041·716	11281·669	293323·385	39·394
73	93	293362·779	11734·511	305097·290	22·511
74	94	305119·801	12204·792	317324·593	11·256
75	95	317335·849	12693·434	330029·283	5·628
76		330034·911	13201·396	343236·307	

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE V.—*PROGRESS OF THE FUND.*

(Arts. 38. & 35.)

Exhibiting the Progress of the Fund (for 75 years) of a Society of 1000 persons all in the middle of the 21st year of age, when the Contributions and Distributions commence, admitting no new members, but decreasing in number by the Law of Mortality, contributing each £1 ₱ annum for 50 years, and distributing £5·627782 ₱ annum to each of their Widows till all are dead.

(Annual Distribution supposed to be made at the middle of each year.)

1.	2.	3.	4.	5.	6.	7.
Year of Sch.	Age.	Number Living.	Amount of Contribution.	Amount of Distribution.	Balance or Nett Stock of Society.	Individual Stock.
1	21	1000				
2	22	990	£1040·000	£58·529	£981·471	£ ·9914
3	23	980	2111·200	177·928	1933·272	1·9727
4	24	970	3214·848	354·779	2860·069	2·9485
5	25	960	4352·242	591·380	3760·862	3·9176
6	26	950	5524·732	890·121	4634·611	4·8785
7	27	940	6733·721	1253·488	5480·233	5·8300
8	28	930	7980·670	1684·066	6296·604	6·7705
9	29	920	9267·096	2184·542	7082·554	7·6984
10	30	910	10594·580	2751·861	7842·719	8·6184
11	31	900	11964·763	3388·696	8576·067	9·5290
12	32	890	13379·354	4097·827	9281·527	10·4287
13	33	879	14840·128	4882·147	9957·981	11·3288
14	34	868	16347·893	5744·663	10603·230	12·2157
15	35	857	17904·529	6688·502	11216·027	13·0875
16	36	846	19511·990	7716·919	11795·071	13·9422
17	37	835	21172·310	8833·295	12339·015	14·7773
18	38	824	22887·602	10035·296	12852·306	15·5975
19	39	812	24660·066	11326·348	13333·718	16·4206
20	40	800	26490·949	12710·011	13780·938	17·2262
21	41	788	28382·587	14189·992	14192·595	18·0109
22	42	776	30337·410	15770·142	14567·268	18·7723
23	43	764	32357·947	17454·469	14903·478	19·5072
24	44	752	34446·825	19241·286	15205·539	20·2201
25	45	740	36606·778	21134·693	15472·085	20·9082
26	46	727	38840·649	23138·953	15701·696	21·5979
27	47	714	41150·355	25258·501	15891·854	22·2574
28	48	701	43538·929	27492·096	16046·833	22·8913
29	49	688	46009·526	29844·299	16165·227	23·4960
30	50	675	48565·427	32319·855	16245·572	24·0675
31	51	661	51210·044	34923·697	16286·347	24·6389
32	52	647	53945·866	37660·957	16284·929	25·1699
33	53	633	56776·601	40531·120	16245·481	25·6643
34	54	619	59795·985	43539·500	16166·485	26·1171
35	55	605	62727·955	46665·775	16052·210	26·5326
36	56	590	65376·704	49975·459	15901·245	26·9513
37	57	755	69125·372	53414·289	15711·083	27·3236
38	58	560	72488·387	57002·378	15486·009	27·6536

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE V.—*Continued.*

Explanation.

Column 3d is Column 4th of Table I. of the Preliminary Tables.
Column 4th is Column 5th of Table I. of Scheme IV. till the age of 71, and Column 3d of Table II. of Scheme IV. after that age.
Column 5th is Column 5th of Table IV. of Scheme IV.
The numbers in Column 6th are found by taking the Difference of the corresponding numbers in Columns 4th and 5th of this Table.
The numbers in Column 7th are found by dividing the corresponding numbers in Column 6th by the corresponding numbers in Column 3d of this Table.

1.	2.	3.	4.	5.	6.	7.
Year of Sch.	Age.	Number Living.	Amount of Contribution.	Amount of Distribution.	Balance or Nett Stock of Society.	Individual Stock.
39	59	544	£75970·323	£60745·696	£15224·627	£27·9864
40	60	528	79574·896	64644·600	14930·296	28·2771
41	61	512	83307·012	68705·313	14601·699	28·5189
42	62	496	87171·772	72928·455	14243·317	28·7164
43	63	479	91174·483	77320·522	13853·961	28·9227
44	64	461	95319·622	81888·272	13431·350	29·1352
45	65	443	99611·847	86632·879	12978·968	29·2979
46	66	423	104057·041	91555·565	12501·476	29·5543
47	67	403	108659·243	96657·599	12001·644	29·7808
48	68	381	113424·733	101940·303	11484·430	30·1429
49	69	359	118357·962	107405·051	10952·911	30·5095
50	70	336	123465·640	113053·271	10412·369	30·9892
51	71	313	128753·706	118886·450	9867·256	31·4289
52	72	290	133903·854	124906·133	8997·721	31·0266
53	73	267	139260·008	131113·927	8146·081	30·5097
54	74	245	144830·409	137511·504	7318·905	29·8731
55	75	224	150623·625	144100·602	6523·023	29·1206
56	76	203	156648·570	150883·030	5765·540	28·4012
57	77	182	162914·513	157866·520	5047·993	27·7362
58	78	163	169431·093	165053·261	4377·832	26·8579
59	79	144	176208·337	172451·385	3756·952	26·0899
60	80	127	183256·670	180075·199	3181·471	25·0510
61	81	110	190586·937	187933·732	2653·205	24·1200
62	82	95	198210·415	196024·664	2185·751	23·0079
63	83	80	206138·832	204369·000	1769·832	22·1229
64	84	67	214384·385	212976·874	1407·511	21·0076
65	85	55	222959·760	221864·681	1095·079	19·9105
66	86	44	231878·151	231043·619	834·532	18·9666
67	87	35	241153.277	240531·185	622·092	17·7741
68	88	27	250799·408	250351·431	447·977	16·5917
69	89	20	260831·384	260517·663	313·721	15·6861
70	90	15	271264·639	271055·428	209·211	13·9474
71	91	10	282115·225	281985·438	129·787	12·9787
72	92	7	293399·834	293323·385	76·449	10·9213
73	93	4	305135.827	305097·290	38·537	9·6342
74	94	2	317341·260	317324·593	16·667	8·3335
75	95	1	330034·911	330029·283	5·628	5·6280
76			343236·307	343236·307		

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE VI.

Values of Contributions and Distributions.

(Arts. 39. & 36.)

Exhibiting, for any given Age from 20 to 70,—
The Individual Stock, or the VALUE of Individual past Contributions;
The Value of Individual future Contributions;
The Value of Individual future Distributions;

The Annual Contribution from 20 to 70 being £1, and the Distribution being £5·627782 per annum for each Widow.

1.	2.	3.	4.	5.
Year of Scheme.	Age.	Value of Past Contributions.	Value of Future Contributions.	Value of Future Distributions.
1	21		£18.1173	£18·1173
2	22	£0·9914	17.9818	18·9732
3	23	1·9727	17.8413	19·8140
4	24	2·9485	17.6955	20·6440
5	25	3·9176	17.5442	21·4618
6	26	4·8785	17.3871	22·2656
7	27	5·8300	17.2238	23·0538
8	28	6·7705	17.0542	23·8247
9	29	7·6984	16.8779	24·5763
10	30	8·6184	16.6944	25·3128
11	31	9·5290	16.5036	26·0326
12	32	10·4287	16.3049	26·7336
13	33	11·3288	16.1163	27·4451
14	34	12·2157	15.9202	28·1359
15	35	13·0875	15.7161	28·8036
16	36	13·9422	15.5037	29·4459
17	37	14·7773	15.2826	30·0599
18	38	15·5975	15.0522	30·6497
19	39	16·4208	14.8303	31·2511
20	40	17·2262	14.5993	31·8255
21	41	18·0109	14.3586	32·3695
22	42	18·7723	14.1078	32·8801
23	43	19·5072	13.8462	33·3534
24	44	20·2201	13.5733	33·7934
25	45	20·9082	13.2882	34·1964

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE VI.—*Continued.*

Values of Contributions and Distributions.

Explanation.

Column 3d is Column 7th of Table V. of Scheme IV.
Column 4th is Column 7th of Table III. of Scheme IV.
The numbers in Column 5th are found by adding the corresponding numbers in Columns 3d and 4th of this Table.

1.	2.	3.	4.	5.
Year of Scheme.	Age.	Value of Past Contributions.	Value of Future Contributions.	Value of Future Distributions.
26	46	£21·5979	£13·0083	£34·6062
27	47	22·2574	12·7160	34·9734
28	48	22·8913	12·4106	35·3019
29	49	23·4960	12·0913	35·5873
30	50	24·0675	11·7571	35·8246
31	51	24·6389	11·4243	36·0632
32	52	25·1699	11·0759	36·2458
33	53	25·6643	10·7107	36·3750
34	54	26·1171	10·3275	36·4446
35	55	26·5326	9·9251	36·4577
36	56	26·9513	9·5180	36·4693
37	57	27·3236	9·0899	36·4135
38	58	27·6536	8·6388	36·2924
39	59	27·9864	8·1781	36·1645
40	60	28·2771	7·6914	35·9685
41	61	28·5189	7·1765	35·6954
42	62	28·7164	6·6308	35·3472
43	63	28·9227	6·0639	34·9866
44	64	29·1352	5·4720	34·6072
45	65	29·2979	4·8399	34·1378
46	66	29·5543	4·1823	33·7366
47	67	29·7808	3·4739	33·2547
48	68	30·1429	2·7214	32·8643
49	69	30·5095	1·8999	32·4094
50	70	30·9892	1·0000	31·9892

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE VII.—*VALUES OF ANNUITIES.*

(Arts. 40. & 41.)

Exhibiting at any age above 20,—
The Value of an Annuity of £1 on a Single Life;
The Value of an Annuity of £1 on Two joint Lives of the same age;
And the Value of an Annuity of £1 to a Woman after the death of her Husband;

INTEREST 4 per cent.

1.	2.	3.	4.	5.
Age.	Single Annuity.	Joint Annuity.	Widow's Annuity.	Widow's Annuity.
21	£18·430	£15·363	£3·067	£3·220
22	18·310	15·241	3·069	3·222
23	18·186	15·115	3·071	3·225
24	18·058	14·984	3·074	3·228
25	17·925	14·847	3·078	3·232
26	17·787	14·706	3·081	3·236
27	17·644	14·559	3·085	3·240
28	17·496	14·406	3·090	3·245
29	17·342	14·247	3·095	3·250
30	17·183	14·082	3·101	3·256
31	17·017	13·909	3·108	3·263
32	16·845	13·729	3·116	3·272
33	16·685	13·571	3·114	3·270
34	16·519	13·408	3·111	3·267
35	16·347	13·237	3·110	3·266
36	16·169	13·060	3·109	3·264
37	15·984	12·875	3·109	3·264
38	15·791	12·682	3·109	3·264
39	15·609	12·511	3·098	3·253
40	15·422	12·333	3·089	3·243
41	15·227	12·148	3·079	3·232
42	15·025	11·955	3·070	3·224
43	14·815	11·754	3·061	3·214
44	14·597	11·544	3·053	3·206
45	14·370	11·325	3.045	3·197
46	14.154	11·125	3·029	3·180
47	13·929	10·917	3·012	3·163
48	13·695	10·700	2·995	3·145
49	13·453	10·473	2·980	3·129
50	13·200	10·235	2·965	3·113
51	12·957	10·015	2·942	3·089
52	12·704	9·786	2·918	3·064
53	12·442	9·546	2·896	3·041
54	12·168	9·295	2·873	3·017
55	11·884	9·030	2·854	2·997
56	11·607	8·782	2·825	2·966
57	11·319	8 521	2·798	2·938
58	11·019	8·246	2·773	2·912

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE VII.—*Continued.*

Explanation.

The numbers in Column 4th are found by taking the difference of the corresponding numbers in Columns 2d and 3d.

The numbers in Column 5th are found by adding to the corresponding numbers in Column 4th a twentieth part of themselves.

1.	2.	3.	4.	5.
Age.	Single Annuity.	Joint Annuity.	Widow's Annuity.	Widow's Annuity.
59	£10·726	£7·986	£2·740	£2·877
60	10·422	7·712	2·710	2·846
61	10·105	7·424	2·681	2·815
62	9·775	7·119	2·656	2·789
63	9·450	6·823	2·627	2·758
64	9·131	6·538	2·593	2·723
65	8·799	6·237	2·562	2·690
66	8·495	5·974	2·521	2·647
67	8·182	5·699	2·483	2·607
68	7·900	5·468	2·432	2·554
69	7·616	5·233	2·383	2·502
70	7·352	5·026	2·326	2·442
71	7·091	4·825	2·266	2·379
72	6·837	4·634	2·203	2·313
73	6·593	4·458	2·135	2·242
74	6·340	4·272	2·068	2·171
75	6·074	4·070	2·004	2·104
76	5·823	3·888	1·935	2·032
77	5·594	3·737	1·857	1·950
78	5·335	3·548	1·787	1·876
79	5·103	3·395	1·708	1·793
80	4·838	3·202	1·636	1·717
81	4·609	3·053	1·556	1·634
82	4·346	2·863	1·483	1·557
83	4·132	2·732	1·400	1·470
84	3·889	2·569	1·320	1·386
85	3·660	2·422	1·238	1·300
86	3·459	2·310	1·149	1·206
87	3·214	2·154	1·060	1·113
88	2·985	2·015	·970	1·019
89	2·787	1·923	·864	·907
90	2·478	1·707	·771	·810
91	2·306	1·660	·646	·678
92	1·941	1·388	·553	·581
93	1·712	1·313	·399	·419
94	1·481	1·250	·231	·243
95	1·000	1·000		

SCHEME IV.—*WIDOWS' ANNUITY.*

TABLE VIII.

Values of Contributions and Distributions, and Increase and Diminution of Annual *Contribution and Distribution.*

(Art. 42.)

Exhibiting, for any given age from 20 to 70,—
- The Value of Entry-Money;
- The Value of Individual Future Contributions;
- The Value of Future Distributions of an Entrant;
- The Increase of Annual Contribution to compensate for Entry-Money;
- And the Diminution of Distribution to supersede the Increase of Future Contributions:

The Annual Contribution from the age of Entry to 70 being £1, and the Distribution being £5·627 per annum for each Widow.

1.	2.	3.	4.	5.	6.	7.
	Age.	Value of Entry-Money.	Value of Future Contrib.	Value of Future Distrib.	Increase of Annual Contrib.	Diminution of the Distribution.
	21		£18·1173	£18·1173	£1·000	£5·627
	22	£ ·1438	17·9818	18·1256	1·008	5·580
	23	·3033	17·8413	18·1446	1·017	5·532
	24	·4601	17·6955	18·1556	1·026	5·482
	25	·6295	17·5442	18·1737	1·036	5·428
	26	·8172	17·3871	18·2043	1·047	5·374
	27	·9990	17·2238	18·2228	1·058	5·316
	28	1·1938	17·0542	18·2480	1·070	5·256
	29	1·4009	16·8779	18·2788	1·083	5·193
	30	1·6194	16·6944	18·3138	1·097	5·127
	31	1·8484	16·5036	18·3520	1·112	5·058
	32	2·1033	16·3049	18·4082	1·129	4·983
	33	2·2724	16·1163	18·3887	1·141	4·929
	34	2·4517	15·9202	18·3719	1·154	4·873
	35	2·6560	15·7161	18·3721	1·169	4·812
	36	2·8682	15·5037	18·3719	1·185	4·750
	37	3·0871	15·2826	18·3697	1·202	4·682
	38	3·3115	15·0522	18·3637	1·220	4·611
	39	3·4703	14·8303	18·3006	1·234	4·55[illegible]
	40	3·6498	14·5993	18·2491	1·250	4·5[illegible]
	41	3·8337	14·3586	18·1923	1·267	4·442
	42	4·0348	14·1078	18·1426	1·286	4·376
	43	4·4696	13·8462	18·0831	1·306	4·308
	44	4·7650	13·5733	18·0389	1·329	4·234
	45	4·7040	13·2882	17·9922	1·354	4·156

SCHEME IV.—*WIDOW'S ANNUITY.*

TABLE VIII.—*Continued.*

Values of Contributions and Distributions, and Increase and Diminution of Annual *Contribution and Distribution.*

Explanation.

The numbers in Column 3d are found by taking the difference of the corresponding numbers in Columns 4th and 5th of this Table.

Column 4th is Column 7th of Table III. of Scheme IV.

The numbers in Column 5th are found by multiplying the numbers in Column 4th by the corresponding numbers in Column 6th.

The numbers in Column 6th are found by dividing £5·627 by the corresponding numbers in Column 7th.

The numbers in Column 7th are found by dividing the numbers in Column 4th by the corresponding numbers in Column 5th of Table VII. of Scheme IV.

1.	2.	3.	4.	5.	6.	7.
	Age.	Value of Entry-Money.	Value of Future Contrib.	Value of Future Distrib.	Increase of Annual Contrib.	Diminution of the Distribution.
	46	£4·8911	£13·0083	£17·8994	£1·376	£4·091
	47	5·0737	12·7160	17·7897	1·399	4·020
	48	5·2869	12·4106	17·6975	1·426	3·496
	49	5·5136	12·0913	17·6049	1.456	3·864
	50	5·7610	11·7571	17·5181	1·490	3·777
	51	5·9521	11·4243	17·3764	1·521	3·698
	52	6·1582	11·0759	17.2341	1·556	3·615
	53	6·3943	10·7107	17·1050	1·597	3·522
	54	6·6406	10·3275	16·9681	1·643	3·424
	55	6·9376	9·9251	16·8627	1·699	3·312
	56	7·1671	9·5180	16·6851	1·753	3·209
	57	7·4355	9·0899	16·5254	1·818	3·094
	58	7·7404	8·6388	16·3792	1·896	2·967
	59	8·0064	8·1781	16·1845	1·979	2·842
	60	8·3144	7.6914	16·0058	2·081	2·703
	61	8·6630	7·1765	15·8395	2·207	2·549
	62	9·0577	6·6308	15·6885	2·366	2·377
	63	9·4536	6·0639	15·5175	2·559	2·198
	64	9·8441	5·4720	15·3161	2·799	2·001
	65	10·2945	4·8399	15·1344	3·127	1·799
	66	10·7109	4·1823	14·8932	3·561	1·580
	67	11·1929	3·4739	14·6668	4·222	1·333
	68	11·6449	2·7214	14·3663	5·279	1·066
	69	12·1765	1·8999	14·0764	7·409	0·759
	70	12·7400	1·0000	13·7400	13.740	0·410

IV.

APPLICATION

OF

THE TABLES.

43. From these Tables it appears, that, if the rate of mortality, the rate of sickness, and the rate of interest, be as supposed, a Society,—formed of any number of individuals, all in the beginning of the 21st year of their age *, contributing each L. 4 for all the allowances, or L. 1 for each kind of allowance, annually, for 50 years, provided they lived so long,—or paying down at once, in the middle of the first year, L. 72.468, or L. 72 : 9 : $4\frac{1}{4}$, for all the allowances, or L. 18.117, or L. 18 : 2 : 4 for each kind of allowance,—would be able to afford to its members,

1*st*, An allowance of L. 1.029725 or L. 1 : 0 : 7 for each week of sickness they might experience from the beginning of the 21st till the beginning of the 71st year of age;

* In the Tables, the contributions and distributions are supposed, for the convenience of computation, to be made annually: but, as Friendly Societies make their contributions at intervals throughout the year, and their distributions as exigencies require, and, of course, also at intervals throughout the year; in order to obviate the error arising from this circumstance, the annual contributions and distributions are supposed to be made at the middle of the *year of age*; and, of course, by and to the average number of members alive throughout the year.

2dly, An annuity for life of L.58.01095, or L.58, 0s. $2\frac{1}{2}$d., to each who might survive his 70th year;

3dly, An allowance of L.59.95842, or L.59 : 19 : 2 at the death of each, for defraying the expense of his funeral, or for other purposes *; and,

4thly, An annuity for life of L. 5.627782, or L. 5, 12s. $6\frac{3}{4}$d., to the widow of each.

These contributions and allowances may be called, for the sake of distinction, the *Standard Contributions* and *Allowances*, and will be occasionally referred to under this denomination.

44. In these Tables are also shewn,

1st, The stock or value of the past contributions of each member of such society in any year of his age, supposing the annual contributions and allowances to be as above, *or* the entry-money to be paid by a person admitted into the society at that age;

2dly, The value, at any age, of a member's annual contributions after that age, *or* what he ought to pay to be free from all future contributions;

3dly, The value, at any age, of a member's allowances after that age;

4thly, To what the annual contributions must be increased, to afford the standard allowances, if the society be formed of persons of any higher age than 21, and no entry-money be paid; and,

* This allowance for funerals is properly only for those of members; but, as the mortality and ages of members' wives are supposed to be the same, it will answer also for those of members' wives or widows.

5thly, To what the allowances must be diminished, to admit of the standard annual contributions in the same circumstances.

RULES.

45. We now proceed to point out more particularly the method of applying these Tables to use. And this we shall do in the form of Problems, premising four Rules, which are necessary for facilitating the calculations.

1st, For converting different kinds of sick allowances into one uniform allowance;
2d, For converting decimals of a pound into shillings and pence;
3d, For converting the contributions and allowances in the Tables into any others; and,
4th, For accumulating and discounting money at 4 *per cent.* compound interest.

46. RULE I.—Supposing a society to have ascertained, from experience, the proportion which each kind of sickness, for which different allowances are made, bears to the whole sickness, to convert *the different rates* of sick allowances into *one uniform rate* of allowance.

Multiply the number of weeks expressing the quantum of each kind of sickness, by the allowance appropriated to it; add the products, and divide the sum by the number of weeks expressing the whole quantum of sickness of all kinds.

Thus, if the approximations given in Art. 8., were agreeable to the experience of any society, and the

Allowance for Bedfast Sickness were		5s.,
	Walking ditto, .	3s.,
	Permanent ditto, .	1s. 8d.

Then we have,

2	multiplied by	5s.	equal	10s.
5	. .	3s.	.	15s.
3	. .	1s. 8d.	.	5s.
10 weeks,	. .			30s.

The sum of these products is 30s.; and 30s. divided by 10, gives 3s. for the uniform rate of allowance.

Again, if the

Allowance for Sickness of the 1st Quarter were	6s.
ditto of the 2d and 3d do., .	3s.
ditto of unlimited duration,	1s.;

Then, we have

$2\frac{1}{2}$	multiplied by	6s.	equal	15s.
3	. .	3s.	.	9s.
$4\frac{1}{2}$	. .	1s.	.	4s. 6d.
10 weeks	. .			28s. 6d.

The sum of these products is 28s. 6d.; and this sum, divided by 10, gives 2s. 10d. for the uniform rate of allowance.

47. Rule II.—To convert decimals of a pound into shillings and pence.

Double the first decimal on the right of the point for shillings, increasing this number by 1, *if the* 2d *decimal be* 5, *or above it.*

Consider the number expressed by the 2d and 3d decimals (deducting 50, if 1 was added to the shillings), as farthings; diminishing this number, however, by 1, if it be above 12, and less than 37; and by 2, if it be above 36.

The other decimals may be neglected.*

Thus, L. 1.029725 is L. 1 : 0 : 7; for, as the first decimal is 0, and the second is below 5, there are no shillings; but the 2d and 3d decimals make 29 farthings, which must be diminished by 1, because 29 is above 12 and under 37; and, therefore, we have 28 farthings or 7d.

Again, L. 58.01095 is L. 58 : 0 : $2\frac{1}{2}$, because there are only 10 farthings, or $2\frac{1}{2}$d.

Again, L. 59.95842 is L. 59 : 19 : 2; for the double of 9, the first decimal, is 18, and this increased by 1, because the 2d decimal is 5, becomes 19 shillings; the 2d and 3d decimals make 58 farthings, from which 50 being deducted, as 1 was added to the shillings, there remain 8 farthings or 2d.

Lastly, L. 5.627782 is L. 5 : 12 : $6\frac{1}{2}$; for twice 6 make 12 shillings, and 27 farthings diminished by 1, as 27 is above 12, and below 37, make $6\frac{1}{2}$d.

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* The reasons of the Rule are, that

.1 or $\frac{1}{10}$ of L. 1 = 2s., and .05 or $\frac{5}{100}$ or $\frac{1}{20}$ of L. 1 = 1s.; .050 or $\frac{50}{1000}$ of L. 1 = $\frac{48}{960}$ of L. 1 = 48 farthings, and .025 or $\frac{25}{1000}$ of L. 1 = $\frac{24}{960}$ of L. 1 = 24 farthings; 13 is the mean betwixt 1 and 25, and 37 is the mean betwixt 24 and 50; .0005 or $\frac{5}{10000}$ or $\frac{1}{2000}$ of L. 1 is less than half a farthing.

48. RULE III.—To convert the Contributions and Allowances in the Tables, into any others.

Increase or diminish the Values of the Contributions or Allowances in the Tables, in proportion as the given Annual Contribution is greater or less than the Standard Annual Contribution, or as the given Allowances are greater or less than the Standard Allowances.

Thus, *at the age of* 31, the value of past contributions or individual stock, in Table VI. of Scheme I. Col. 3., is L. 5.2234 or L. 5 : 4 : 5½ ; and if the *given* annual contribution be 5s.,—to find the *stock* corresponding to it, we have the following proportion:

As L.	1	0	0,	the standard annual contribution :
To	0	5	0,	the given annual contribution : :
So	5	4	5½,	the stock at the given age in the Table ;
To	1	6	1¼,	*the value required**.

Again, at the same age in the same Table, Col. 4., the value of the future contributions is L. 16.5036, or L. 16 : 10 : 0¾ ; and if the *given* annual contribution be 5s.,—to find the value of the *future contributions* corresponding to it, we say :

As L.	1	0	0,	the standard annual contribution :
To	0	5	0,	the given annual contribution :
So	16	10	0¾,	the value of the future contributions at the given age in the Table :
To	4	2	6,	*the value required.*

Again, at the same age in the same Table, Col. 5., the value of the future distributions is L. 21.7270,

* See Note at Art. 33.

or L. 21 : 14 : 6½; and if the *given* annual contribution be 5s.,—to find the value *of the future distributions* corresponding to it, we say:

As L. 1	0	0,	the standard annual contribution:	
To	0	5	0, the given annual contribution : :	
So	21	14	6½, the value of future distributions at the given age in the Table:	
To	5	8	7½, *the value required.*	

Again, at the same age in the same Table, Col. 6., the annual contribution commencing at that age, equivalent to the standard allowance after that age, is L. 1.3165, or L. 1 : 6 : 3¾; and, if the *given* annual contribution be 5s.,—to find the *annual contribution* commencing at the given age, corresponding to it, we say:

As L. 1	0	0,	the standard annual contribution
To	0	5	0, the given annual contribution : :
So	1	6	3¾, the annual contribution at the given age in the Table:
To	0	6	7, *the annual contribution required.*

Lastly, at the same age in the same Table, Col. 7., the allowance commencing at that age, equivalent to the standard annual contribution after that age, is L. 0.782168, or 15s. 7¾d.; and if the *given* annual contribution be 5s.—to find the *allowance* commencing at the given age, corresponding to it, we say:

As L. 1	0	0,	the standard annual contribution:
To	0	5	0 the given annual contribution : :
So	0	15	7¾, the allowance at the given age in the Table:
To	0	3	10¾, *the allowance required.*

Or, if the given allowance be 5s. $1\frac{3}{4}$d., then, in all these cases, we have the following proportions :

Standard Allowance.				Given Allowance.				Values in Table at 31.				Values Required.		
L.	S.	D.		L.	S.	D.		L.	S.	D.		L.	S.	D.
								5	4	$5\frac{1}{2}$	:	1	6	$1\frac{1}{4}$
								16	10	$0\frac{3}{4}$	:	4	2	6
1	0	7	:	0	5	$1\frac{3}{4}$	::	21	14	$6\frac{1}{2}$	:	5	8	$7\frac{1}{2}$
								1	6	$3\frac{3}{4}$	:	0	6	7
								0	15	$7\frac{3}{4}$	:	0	3	$10\frac{3}{4}$

Some of these values have been digested into Tables, which are subjoined under the denomination of Practical Tables.

49. RULE IV.—To accumulate and discount money at 4 *per cent.* compound interest for any number of years :

1*st*, To accumulate money :

Divide the given sum by 25, and add the quotient to it, this is the amount for one year ; continue the same process for the given number of years, and the last sum is the amount required.*

2*d*, To discount money :

Divide the given sum by 26, and subtract the quotient from it, this is the money discounted for one year ; continue the process for the given number of years, and the last remainder is the discounted value required †.

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* A short way of dividing by 25, is to multiply by 4, and then divide by 100, which is done, in decimals, by moving the decimal Point 2 places to the left. Thus, $13.2942 \times 4 = 53.1768$ and $\frac{53.1768}{100} = .531768$, or cutting it short at 4 places .5318.

† The reasons of the Rules are, that

$$100 : 4 :: 25 : 1$$
$$\text{and } 104 : 4 :: 26 : 1.$$

Thus, we find that L. 13.2942, or L. 13 : 5 : $10\frac{1}{2}$, will amount to L. 14.9542, or L. 14 : 19 : 1, when accumulated for 3 years at 4 *per cent.* compound interest; and, as discounting is the reverse of accumulating, that L. 14.9542 is reduced to L. 13.2942, when discounted for the same number of years at the same rate of interest. The operations are as follow:

Accumulating.	*Discounting.*
25)13·2942 principal.	26)14.9542 principal.
add .5318 interest.	subtract .5752 discount.
25)13.8260	26)14.3790
add .5530	subtract .5530
25)14.3790	26)13.8260
add .5752	subtract .5318
14.9542 amount.	13.2942 discounted value.

When the given number of years is many, this method is tedious; and, therefore, tables are given in most books of arithmetic, for finding the values more easily. *Table II. of all the Schemes* is a table of this kind, though not so simple as it might be, as it is not an accumulation of L. 1 *, but of L. 18,117.271. To determine the values from this Table, we have only to *increase* or *diminish*, according as we wish to *accumulate* or *discount*, the

* A double Table of this kind (Table I.) shewing the accumulation and discounting of L. 1 is inserted at the end of the Appendix No. I., and carried to 12 places of decimals; but so many may be used only as are thought necessary.

given sum, in the same proportion as any sum in the Table is *increased* or *diminished*, by going *forward* or *backward* for the given number of years.

Thus, for the former examples, we have the following proportions:

As L. 18117.271, the sum at the head of the Table:
To 13.2942, the given sum:
So 20379.466, its accumulation in the 3d year after::
To 14.9542, *the amount required.*

And,

As L. 20379.466, the sum in the table at the 4th year:
To 14.9542, the given sum:
So 18117.271, the same sum discounted 3 years::
To 13.2942, *the discounted sum required**.

PROBLEMS.

50. The following seem to be the principal Problems that require notice.

1*st*, To determine from the Tables the *Annual Contribution*, corresponding to any given Allowances, if a Society be formed of persons, all in any given year of their age betwixt 20 and 70.

2*d*, To determine the *Single Contribution* paid down at entry, equivalent to an Annual Contribution, in the same circumstances.

* Or by Table I. at the end of the Appendix No. I.
1.00000 : 1.124864 : : 13.2942 : 14.9542
1.00000 : .888996 : : 14.9542 : 13.2942

3d, To determine the *Annual Contribution* as before, when an *Entry-money is paid*, in addition to such Annual Contribution.

4th, To determine the *Annual Contribution* as before, when the members of the Society *are not* entitled to any benefit from it till after a *given number of years*.

5th, To determine the *Entry-money* of each member, when a Society is formed of persons of all different ages from 20 to 70, in addition to a given Annual Contribution.

6th, To determine, at any time, the *Stock* which a Society ought to be possessed of, in order to be able to fulfil *all its obligations*.

7th, To determine the *Allowances*, &c. if the *distribution of Allowances* should be *deferred to a later age* than that at which the *Annual Contributions commence*.

8th, To determine the *allowances*, &c. if the *Annual Contributions* should be made to *terminate at an earlier age* than that fixed in the Tables.

9th, To determine the *values*, at any age, of the *Future Contributions* and *Distributions*, if the Distributions should *not commence till after* the commencement of the Contributions, or the Contributions *be terminated before* the termination of the Distributions.

The materials for solving these problems, will all be found in Table VI. of the first three Schemes, Tables VII. and VIII. of Scheme IV., and, in a few instances, in Table V. of Scheme II, and III.

Problem I.

51. If a Friendly Society were formed, consisting of persons all in the 21st or any given year of their age, and this Society proposed to make to its members *Allowances different from the Allowances* in the Tables,—it is required to *determine* from the Tables, the *Annual Contribution* of each member, from the time of admission till he reach the end of his 70th year, necessary for providing the allowances assumed, supposing no entry-money to be paid.

As Table VI. of Schemes I. II. and III., and Table VIII. of Scheme IV., cols. 6., contain the Annual Contributions, commencing at any age between 20 and 70, and continuing till 70, corresponding to the Standard Allowances of the Tables; we have only to

Take from the 6th columns of Table VI. of Schemes I. II. and III., and Table VIII. of Scheme IV., the sums opposite the given age in column 2.; and, after having reduced them by Rule 3. Art. 48., in the proportion of the assumed Allowances to the Standard Allowances of the Tables, add them together, and the amount is the Annual Contribution required.

Thus, suppose that the proposed Allowances to the members are, as follow:

5s. for each week of Sickness of every kind they might experience, from the time of admission till they reached the end of their 70th year.

L. 5 of Annuity for life after 70 years of age;

L. 3 to defray their own Funeral expenses; and,

L. 2 to defray those of their wives or widows; or,

L. 5 to defray Funeral expenses, in all; and,

L. 5 of Annuity for life to the widows they might leave.

Then, *if the given age of the members of the Society* be 21, the sums opposite that age in the Tables are the Standard Annual Contributions of L. 1; and the Standard Allowances of the Tables, are

L. 1.029725, or	L. 1	0	7,	the Sick Allowance;
58.01095,	58	0	$2\frac{1}{2}$,	the Annuity for old age;
59.95842,	59	19	2,	the Funeral Allowance;
5.627782,	5	12	$6\frac{1}{2}$,	the Widows' Annuity.

Now the *Standard Annual Contributions* being reduced in proportion as the Allowances assumed above are less than the *Standard Allowances*, become,

* L. 0	4	10,	the Annual Contribution	for Sickness;
0	1	$8\frac{3}{4}$,	do.	for Old Age Annuity;
0	1	8,	do.	for Funeral Expenses;
0	17	$9\frac{1}{4}$,	do.	for Widows' Annuity.

The sum of these Annual Contributions is L. 1, 6s., which, consequently, is the Annual Contribution required, at the age of 21 for these allowances.

Again, *if the given age be* 31, the sums opposite that age in the Tables, are

L. 1.31650, or	L. 1	6	$3\frac{1}{2}$,	Contribution	for Sickness;
1.80553,	1	16	$1\frac{1}{4}$,	do.	for Old Age Annuity;
1 30149,	1	6	$0\frac{1}{4}$,	do.	for Funeral Expences;
1.11200,	1	2	3,	do.	for Widows' Annuity.

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* L. 1	0	7	:	L. 0	5	0	::	L. 1	:	L. 0	4	10
58	0	$2\frac{1}{2}$	:	5	0	0	::	1	:	0	1	$8\frac{3}{4}$
59	19	2	:	5	0	0	::	1	:	0	1	8
5	12	$6\frac{1}{2}$	:	5	0	0	::	1	:	0	17	$9\frac{1}{4}$
										L. 1	6	0

And these *Annual Contributions* being reduced in proportion as the *assumed* allowances are less than the *Standard Allowances*, become,

* L. 0	6	$4\frac{1}{2}$,	the Annual Contribution	for Sickness ;
0	3	$1\frac{1}{4}$,	do.	for Old Age Annuity ;
0	2	2,	do.	for Funeral Expenses ;
0	19	$9\frac{1}{4}$,	do.	for Widows' Annuity.

The sum of these is L. 1 : 11 : 5, which is therefore the Annual Contribution required at the age of 31 for the same allowances.

Problem II.

52. If the Society supposed in Problem I., allowed any of its members to pay down a *single sum* of money at entry, instead of making any *Annual Contribution*,—it is required to *determine* from the Tables the *Single Contribution* equivalent to the annual contribution corresponding to any proposed allowances.

As Table VI. of each Scheme col. 4., contains the values of the future contributions after any age, or the single contributions equivalent to an annual contribution of L. 1 from any age till 70 ; and as we can find by Problem I., the annual contribution corresponding to any given allowances ; we have only to

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* L. 1	0	7	:	L. 0	5	0	: :	L. 1	6	$3\frac{3}{4}$	:	L. 0	6	$4\frac{1}{2}$
58	0	$2\frac{1}{2}$	:	5	0	0	: :	1	16	$1\frac{1}{4}$	:	0	3	$1\frac{1}{4}$
59	19	2	:	5	0	0	: :	1	6	$0\frac{1}{4}$	:	0	2	2
5	12	$6\frac{1}{2}$	:	5	0	0	: :	1	2	3	:	0	19	$9\frac{1}{4}$
												L. 1	11	5

Take from Column 4. of Table VI. of any of the Schemes, the sum opposite the given age in Column 2; and this, when reduced by Rule 3. Art. 48., in the proportion of the given annual contribution to the Standard Annual Contribution,—is the Single Contribution required.

Thus, suppose that the allowances are the same as those assumed in Problem I., then, *if the given age of the members of the society* be 21, the annual contribution commencing at that age, corresponding to the assumed allowances, is L. 1, 6s., as was found in Problem I.; and the single contribution in col. 4., opposite that age in col. 2. of the Tables, equivalent to an annual contribution of L. 1 from that age till 70, is L. 18.117 or L. 18 : 2 : 4.

And L. 18 : 2 : 4—being increased in the same proportion as L. 1, 6s. is greater than the *standard annual contribution of* L. 1, — becomes L. 23, 11s. 0¼d. *, which is the single contribution required at the age of 21, for the assumed allowances.

Again, *if the given age be* 31, the annual contribution commencing at this age, corresponding to the assumed allowances, is L. 1 : 11 : 5., as was found in Problem I.; and the single contribution in the Tables is L. 16.5036 or L. 16 : 10 : 0¾.

And L. 16 : 10 : 0¾—being increased in the same proportion as L. 1 : 11 : 5 is greater than the *standard annual contribution,*—becomes L. 25 : 18 : 6¼ †, which is the single contribution required, at the age of 31 for the same allowances.

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* L. 1 0 0 : L. 1 6 0 :: L. 18 2 4 : L. 23 11 0¼.

† L. 1 0 0 : 1 11 5 :: 16 10 0¾ : 25 18 6¼.

Problem III.

53. If the Society supposed in Problem I. proposed, that each member should pay down L. 1 of *Entry-money* or a *given sum* at first, besides an *Annual Contribution*,—it is required to *determine* how much the *annual contribution* would be diminished by this *entry-money*.

It is obvious, that the solution of this problem depends upon *finding the annual contribution equivalent to a single contribution, or the given entry-money*, which is the converse of the last Problem; and, therefore, we have only to

> *Reduce the Standard Annual Contribution of the Tables, in the proportion of the given Single Contribution to the Single Contribution or value of Future Contributions in Column 4. of Table VI. of any of the Schemes, opposite the given age in Column 2.; and diminish the given Annual Contribution by the sum so found.*

Thus, if *the given age of the members of the Society* be 21, and *the given single contribution or entry-money*, be L. 1; then, as the single contribution in col. 4., opposite that age in col. 2. of the Tables, equivalent to an annual contribution of L. 1 from that age till 70, is L. 18.117 or L. 18 : 2 : 4; the annual contribution equivalent to L.1 of entry-money, at the same age, is 1s. 1¼d., since 1s. 1¼d. bears the same proportion to L. 1, that L.1 does to L. 18, 2s. 4d.*. The annual contribution commencing at 21 years of age, therefore, is to be diminished by the sum of 1s. 1¼d., when an entry-money of L. 1 is paid.

* L. 18 2 4 : L. 1 0 0 :: L. 1 0 0 : L. 0 1

If the annual contribution commencing at this age be L. 1, 6s., as was found in Problem I., corresponding to the allowances assumed in that Problem, then it is diminished to L. 1 : 4 : 10$\frac{3}{4}$ by the payment of L. 1 at entry;—and for every sum of L. 1 of entry-money there will be a corresponding *diminution* of the annual contribution.

Again, if *the given age be* 31, and the *given entry-money* L. 1, the annual contribution equivalent to that sum paid down at that age is 1s. 2$\frac{1}{2}$d.; for the single contribution in col. 4. of the Tables, opposite age 31, equivalent to an annual contribution of L. 1 from that age till 70, is L. 16.5036, or L. 16, 10s. 0$\frac{3}{4}$d., and 1s. 2$\frac{1}{2}$d. has the same ratio to L. 1, that L. 1 has to L. 16 : 10 : 0$\frac{3}{4}$ *.

If the annual contribution commencing at 31 be L. 1 : 11 : 5, as was found in Problem I., corresponding to the allowances assumed in that Problem,—then, by deducting 1s. 2$\frac{1}{2}$d, it becomes L. 1 : 10 : 2$\frac{1}{2}$, which is the annual contribution commencing at 31, corresponding to these allowances, when an entry-money of L. 1 is paid at that age, besides the annual contribution;—and, in like manner, the annual contribution will be *diminished* 1s. 2$\frac{1}{2}$d. for every sum of L. 1 of entry-money paid down at that age, and proportionally for any lesser sum †.

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* L. 16 10 0$\frac{3}{4}$: L. 1 0 0 :: L. 1 0 0 : L. 0 1 2$\frac{1}{2}$

† See Table IX. of Practical Tables.

PROBLEM IV.

54. If the Society supposed in Problem I., resolved, that none of its members should become *Free*, till after a certain number of years from the commencement of the Society, or, in other words, that no member should be entitled to any allowances whatever, except in the event of his surviving the given number of years,—it is required to *determine* what the *annual contribution* from the age of entry would be in this case.

In order to solve this problem, it is only necessary to determine, what the value of the *future annual contributions* at the age when the allowances commence, will be, when paid down the given number of years *previous* to that age. This value obviously depends upon the accumulation of money by interest during the interval of years, and the probability that a person has of living from the beginning to the end of that interval; and, therefore, it is found by—discounting the given value for the given number of years,—and multiplying the result by the chance* of a person living from the age of entry to the age at which the allowances commence.

* The chance of one person living from one age to another, is expressed by the fraction whose numerator is the future age, and whose denominator is the present; and the chance of two persons of equal age, continuing in life together for the same period, is denoted by the square of the fraction found in the case o fa single life. See second note at art. 26.

To multiply by a fraction, is to multiply by the numerator and divide by the denominator.

In the case of the Fund for Widows, we must multiply by the chance of two persons continuing in life together, for the given interval of years.

Whence, we have, for the solution of this problem, the following rule.

> *Find, by Problem II. the Single Contribution payable at the age at which the right to Allowances commences, equivalent to the given Allowances.*
>
> *Discount by Rule 4. Art. 49., this sum at 4 per cent. compound interest, for the number of years from the time of entry, to the time when the member becomes Free.*
>
> *Multiply the part of the result which belongs to Schemes I. II. and III., by the number of living in the Mortality Table, at the age when the Allowances commence,—and divide the product by the number of living in the table at the age of entry;—and multiply and divide the part which belongs to Scheme IV., by the squares of these numbers;—add the sums together, and the amount is the value of the Single Contribution.*
>
> *Convert this Single Contribution into an equivalent Annual Contribution by Problem III., and this is the Annual Contribution required.*

Thus, *if the age of entry to the society be* 21, and the members *do not become free till after the lapse of* 3 *years*, and consequently 24 be the age at which the allowances commence, then, if the allowances be the same as those assumed in Problem I, we find by that Problem, that the *annual contribution commencing at* 24, equivalent to these allowances commen-

cing at that age, is L. 1 : 7 : 3½ *;—and, by Problem II., that the *single contribution* equivalent to this annual contribution is L. 24 : 3 : 1 †.

This sum of L. 24 : 3 : 1, *discounted* for 3 years, at 4 per cent., by Rule 4. Art. 49. becomes L. 21. 9s. 5½d. ‡,—of which, L. 14 : 6 : 10 § is the contribution for Widows' annuity, and L. 7 : 2 : 7½ for the other allowances. The latter of these sums, *multiplied* by 970, the number of living in the Mortality Table at 24 years of age,—and *divided* by 1000, the number of living at 21, gives L. 6 : 18 : 4 ; and the former, *multiplied* by the square of 970, and *divided* by the square of 1000 ; or || *multiplied twice by* 970, *and divided twice by* 1000, gives L. 13 : 9 : 10½. The sum of these, L. 20 : 8 : 2½, is the single contribution payable at 21, equivalent to an annual contribution of L. 1 : 7 : 3½ commencing at 24, and continuing till 70 years of age.

	L.	S.	D.		L.	S.	D.		L. decim.		L.	S.	D.		L.	S.	D.
*	1	0	7	:	0	5	0	::	1.07615	or	1	1	6¼	:	0	5	2¾
	58	0	2½	:	5	0	0	::	1.18730		1	3	9	:	0	2	0½
	59	19	2	:	5	0	0	::	1.07389		1	1	5½	:	0	1	9½
	5	12	6½	:	5	0	0	::	1.026		1	0	6¼	:	0	18	2¾
															1	7	3½

	L.	S.	D.		L.	S.	D.		L. decim.		L.	S.	D.		L.	S.	D.
†	1	0	0	:	1	7	3½	::	17.6955	or	17	13	10¼	:	24	3	1
‡	1	0	0	:	0.888996			or	0 17 9¼	::	24	3	1	:	21	9	5½
§	1	7	3½	:					21 9 5½	::	0	18	2¾	:	14	6	10

|| The square of any number is the product of that number multiplied by itself; and, therefore, to multiply or divide by the square of a number, is to multiply or divide twice by that number.

Now, we find, by Problem III., that a single contribution of L. 20 : 8 : $2\frac{1}{2}$, at 21 years of age, is equivalent to an annual contribution of L. 1 : 2 : $6\frac{1}{4}$ * commencing at that age. *This, therefore, is the annual contribution required, since it is equivalent to the given allowances commencing at 24 years of age.*

Again, *if the age of entry to the Society be* 31,—and the age at which the right to the allowances commences be 34,— we find, by Problem I., that the *annual contribution commencing at* 34, equivalent to the assumed allowances commencing at that age, is L. 1 : 13 : $8\frac{1}{4}$ † ;—and, by Problem II., that the *single contribution* equivalent to this annual contribution is L. 26 : 16 : 3 ‡.

This sum of L. 26 : 16 : 3, discounted for 3 years, at 4 per cent, by Rule 4., Art. 49., is reduced to L. 23 : 16 : $8\frac{1}{2}$ §,—of which, L. 14 : 10 : 1 ‖ is the

	L. decim.		L.	S.	D.		L.	S.	D.		L.	S.	D.		L.	S.	D.
*	18.1173	or	18	2	4	:	20	8	$2\frac{1}{2}$	::	1	0	0	:	1	2	$6\frac{1}{4}$

	L.	S.	D.		L.	S.	D.		L. decim.		L.	S.	D.		L.	S.	D.
†	1	0	7	:	0	5	0	::	1.45375	or	1	9	$0\frac{3}{4}$	:	0	7	$0\frac{3}{4}$
	58	0	$2\frac{1}{2}$	:	5	0	0	::	2.18302		2	3	8	:	0	3	9
	59	19	2	:	5	0	0	::	1.38176		1	7	$7\frac{1}{2}$	:	0	2	$4\frac{1}{2}$
	5	12	$6\frac{1}{2}$	:	5	0	0	::	1.154		1	3	1	:	1	0	6
															1	13	$8\frac{1}{4}$

	L.	S.	D.		L.	S.	D.		L. decim.		L.	S.	D.		L.	S.	D.
‡	1	0	0	:	1	13	$8\frac{1}{4}$	::	15.9202	or	15	18	$4\frac{3}{4}$	:	26	16	3

§	1	0	0	:	0.888996	or	0	17	$9\frac{1}{4}$	::	26	16	3	:	23	16	$8\frac{1}{2}$	
‖	1	13	$8\frac{1}{4}$	:			23	16	$8\frac{1}{2}$	::	1	0	6	:	14	10	1	

contribution for Widows' Annuity, and L. $9:6:7\frac{1}{2}$ for the other allowances. Now, the latter of these sums *multiplied* by 868, the number of living in the Mortality Table at 34 years of age,—and *divided* by 900, the number of living at 31, gives L. $9:0:0$; and the former *multiplied* by the *square* of 868, and *divided* by the *square* of 900, gives L. $13:9:9\frac{3}{4}$. The sum of these, L. $22:9:9\frac{3}{4}$, is the single contribution payable at 31 years of age, equivalent to an annual contribution of L. $1:13:8\frac{1}{4}$, commencing at 34, and continuing till 70 years of age.

And we find by Problem III., that a single contribution of L. $22:9:9\frac{3}{4}$ at 31 years of age, is equivalent to an annual contribution of L. 1, 7s. 3d.* commencing at that age, *which, consequently, is the contribution required, since it is equivalent to the given allowances commencing at 34 years of age.*

Problem V.

55. If a Friendly Society were formed, consisting *of persons of all ages*, from 20 to 70, and this society proposed that *all* should pay *equal sums of Annual Contributions*, from the time of entry, till the end of their 70th year,—it is required to *determine* what *Entry-money* each ought to pay in *addition* to the *annual contribution*, on account of the difference of age at the time of entry.

L. decim.		L.	S.	D.		L.	S.	D.		L.	S.	D.		L.	S.	D.
16.5036	or	16	10	$0\frac{3}{4}$	:	22	9	$9\frac{3}{4}$	::	1	0	0	:	1	7	3

As Table VI. of Schemes I., II., III., and Table VIII. of Scheme IV., cols. 3. contain the sums which an individual entering at any later age than 21 ought to pay, in addition to his annual contribution, to be upon the same footing as those who entered at 21, ; it is obvious, that if the annual contributions and allowances adopted by the Society, were the same as the *standard ones*, and members of 21 years of age paid no entry-money, each person ought to pay a sum of entry-money equal to the sum corresponding to his age at the time of entry, as stated in these Tables.

But, if the contributions were different from the standard rates, then we should only have to

> *Take from the 3d columns of Table VI. of Schemes I., II., and III., and Table VIII. of Scheme IV., the sums opposite the given ages in column 2. and after having reduced them by Rule 3. Art. 48., in the proportion of the given Annual Contributions, to the Standard Annual Contributions, add them together, and the amount is the Entry-money required.*

Thus, suppose that *the annual contributions* are,

5s.	Annual Contribution	for Sickness ;
2s.	do.	for Annuity in Old Age ;
2s.	do.	for Allowances at Death ;
11s.	do.	for Annuity to Widows ;

And the *allowances*, as they should be to correspond,

L. 0	5	$1\frac{3}{4}$	per week for Sickness ;
5	16	$0\frac{1}{4}$	of Annuity for life after 70 ;
5	19	11	for Funerals; and,
3	1	11	for Annuity to Widows ;

And, *that no entry-money* is paid by those in their 21st year; then, if there were *some persons in the 26th year of their age*, they should pay each

L. Decim.		L.	S.	D.		AGE.
2.3497,	or	2	6	11¾,	the entry-money	at 26 in Tab. VI. Sch. I.
5.8155,		5	16	3½,		do. do. II.
2.2603,		2	5	2½,		do. do. III.
0.8172,		0	16	4,		do. do. VIII. IV.

after being reduced by Rule 3. Art. 48., as follow:

* L. 0	11	9,	the Entry-money	for Sick-allowance;
0	11	7½,	do.	for Annuity in Old Age;
0	4	6½,	do.	for Funeral Allowance;
0	9	0,	do.	for Widows' Annuity;
L. 1	16	11,	the entry-money for all the given allowances at the age of 26.	

Again, if there were *some persons in the 36th year of their age*, they ought to pay down each at admission,

* L. 2	3	5½,	the Entry-money for Sick-allowance;	
2	6	1½,	do.	Annuity in Old Age;
0	15	11½,	do.	Funeral Allowance;
1	11	6½,	do.	Widows' Annuity;
L. 6	17	1,	do.	for all the Allowances.

	L.	S.	D.		L.	S.	D.		L.	S.	D.		L.	S.	D.
*	1	0	0	:	0	5	0	::	2	6	11¾	:	0	11	9
	1	0	0	:	0	2	0	::	5	16	3½	:	0	11	7½
	1	0	0	:	0	2	0	::	2	5	2½	:	0	4	6½
	1	0	0	:	0	11	0	::	0	16	4	:	0	9	0
†	1	0	0	:	0	5	0	::	8	13	9½	:	2	3	5½
	1	0	0	:	0	2	0	::	23	1	3	:	2	6	1½
	1	0	0	:	0	2	0	::	7	19	10	:	0	15	11½
	1	0	0	:	0	11	0	::	2	17	4¼	:	1	11	6½

For, the sums in Col. 3. of Table VI. of Schemes I., II., III., and Table VIII. of Scheme IV., opposite age 36, are,

L. Decim.		L.	S.	D.		
8.6898,	or	8	13	$9\frac{1}{2}$,	the stock in Scheme	I.
23.0638,		23	1	3,	do.	II.
7.9919,		7	19	10,	do.	III.
2.8682,		2	17	$4\frac{1}{4}$,	entry-money,	IV.

and these sums, reduced by Rule 3, are as above.

Problem VI.

56. If, in any Friendly Society, which has subsisted for any length of time, the *ages* of the *members* are given, and also *those* of the *wives* and *widows* belonging to it, with the *rates* of the annual *contributions* and *allowances* adopted,—it is required to *determine* from these Tables, the *Stock* such Society ought to possess, in order to be able to answer all demands that may come against it from its members

In Col. 4. of Table VI. of each Scheme, are contained the values at any age from 20 to 70 of the *standard annual contributions* after that age; and in Col. 5. of Table VI. of Schemes I., II., and III., the values of the future standard *allowances*. It is obvious, that the difference of these is the stock or sum of money required to be paid down at the given age of each individual, besides his future annual contributions, for answering his future allowances. These sums are contained in Col. 3. of Table VI., of Schemes I., II. and III.; and, therefore, if

the given contributions and allowances corresponded to each other, as those in the Tables do, we should only have to *take from Columns 3. of these Tables, the sums opposite the given ages of the members* *; *and, after having reduced them by Rule 3. in proportion to the given contributions, add them together, and the sum would be the stock required.*

With regard to the stock for Widows' Annuities, as Table VI. of Scheme IV. answers only for persons who have entered at 21 years of age, and Table VIII. of Scheme IV. answers only for persons at the age of entry, we must *find the values of Annuities to existing Widows, and of Annuities to expected Widows, separately, and add the sums.* And as Col. 2. of Table VII., contains the value of an annuity of L. 1, to an individual, and consequently to a widow at any age; and Col. 5. contains the value of an annuity of L. 1, to a woman after the death of her husband, we have only *to take the sums opposite to the given ages of the wives and widows, reduce them as before, and add them together.*

* If the society be divided into classes, according to the ages of the members, viz. between 20 and 30, 30 and 40, 40 and 50, 50 and 60, and 60 and 70, and the average age of each class be found by adding up all the ages, and dividing by the number in each class, the whole members of each class respectively may be considered as of this *average age*, and the aggregate of the results obtained upon this supposition will give an approximation to the result that would be obtained by calculating the stock of each individual separately, sufficiently near for any practical purpose.

But, if the given contributions and allowances do not correspond to each other, as those in the Tables do, then we must

First, take from Column 5. of Table VI. of Schemes I., II., and III., the sums opposite the given ages,—and after having reduced them, by Rule 3. Art. 48., in proportion to the given Allowances,—add them together,—and the amount is the present value of all the Future Allowances of the Society for Sickness, for Old Age, and for Funerals. Also, take from Column 2. of Table VII. of Scheme IV., the sums opposite the ages of the widows, and from Column 5. the sums opposite the ages of the wives,—and after having reduced them by Rule 3., Art. 48. in proportion to the given Annuities, add them together, and the amount is the present value of all the Future Allowances of the Society for Widows. Collect both these values into one sum, and this is the value of all the Future Allowances of the Society.

Next, take from Column 4. of Table VI. of any of the Schemes, the sums opposite the given ages, and after having reduced them by Rule 3. Art. 48. in proportion to the given Contribution,—add them together,—and the amount is the value of all the Future Contributions of the Society.

Then deduct the latter sum from the former, and the remainder is the Stock required.

If the age of a member is *above* 70, the value of his *future allowances* is found in Col. 7. of Table V. of Schemes II. and III.; and the value of his *future contributions* is nothing, as the Schemes suppose members to cease contributing after 70 years of age.

Thus, suppose that there are in a society 100 members,

20 of whom are in the	28th year of	their age,
20	38th	do.
20	48th	do.
20	58th	do.
10	68th	do.
10	78th	do.

And suppose that

L. 0 5 $1\frac{3}{4}$ is the Weekly Sick Allowance till 70;
2 18 0 the Annuity for Old Age above 70;
5 19 11 the Allowance for Funerals; and,
2 16 3 the Annuity for Widows;

And that

12s. is the Annual Contribution of each member till he reach the 71st year of his age;

Then, *first* to find the *value of the future allowances* of the society for Sickness, Old Age, and Funerals.

The sums in Col. 5. of Table VI. of Scheme I., II., and III., opposite age 28, 38, 48, 58, 68, and in Col. 7. of Table V. of Schemes II., and III., opposite 78, are respectively

Values of the future Standard Allowances.

Age.	Scheme I.	Scheme II.	Scheme III.
28	20.4899	25.6356	20.3397
38	25.3178	42.8284	24.3932
48	32.0216	74.5203	29.4766
58	36.4695	138.0823	36.0119
68	25.7957	300.4241	44.3547
78		309.4756	52.0194

The sums opposite the four first ages being mul-

tiplied by 20, the number of members at those ages, and those opposite the two last by 10, the number of members at those ages, we get

Age.			
28	409.7980	512.7120	406.7940
38	506.3560	856.5680	487.8640
48	640.6320	1490.4060	589.5320
58	729.3900	2761.6460	720.2380
68	257.9570	3004.2410	443.5470
78	.	3094.7560	520.1940
	2544.1330	11720.3290	3168.1690

And these sums being reduced by Rule 3., Art. 48., in proportion to the above given allowances, we have

* L. 636,0332, or	L. 636	0	8,	value of future Sick Allowances;
586.0164, or	586	0	$3\frac{3}{4}$,	do. of future Annuities for Old Age;
316.8169, or	316	16	4,	do. of future Funeral Allowances;
L. 1538.8665 or	L.1538	17	$3\frac{3}{4}$,	the present value of all the future allowances to the members of the society for Sickness, Old Age, and Funerals.

Again, to find the present value of the future allowances to the widows of members.

Let us suppose, that there are belonging to members of the Society, 65 wives, and 35 widows, of

---

L.	S.	D.		L.	S.	D.		L.	S.	D.		L.	S.	D.
* 1	0	7	:	0	5	$1\frac{3}{4}$	::	2544	2	8	:	636	0	8
58	0	$2\frac{1}{2}$	:	2	18	0	::	11720	6	7	:	586	0	$3\frac{3}{4}$
59	19	2	:	5	19	11	::	3168	3	$4\frac{1}{2}$	:	316	16	4

whom there are

of 28 years of age	18 Wives and	2 Widows
38	16	4
48	14	6
58	11	9
68	4	6
78	2	8
	65 Wives and	35 Widows*.

The sums in Cols. 2. and 5. of Table VII., Scheme IV., opposite the given ages, are respectively

Age.	Widows.	Wives.
28	L. 17.496	L. 3.245
38	15.791	3.264
48	13.695	3.145
58	11.019	2.912
68	7.900	2.554
78	5.335	1.876

These sums, multiplied by the respective numbers of wives and widows of the given ages, become

* These are nearly the numbers of wives and widows that would have existed, according to the law of mortality, had all the members of the society entered it in the 21st year of their age, and been married to women of the same age as themselves, and had no second marriages taken place. For,

No. in Mort. Table.		No. in Wid.'s Tables.		No. of Women.		No. of Widows.	
930	:	74	: :	20	:	1.6	or 2 nearly.
824	:	152	: :	20	:	3.7	4
701	:	214	: :	20	:	6.0	6
560	:	250	: :	20	:	9.0	9
381	:	237	: :	10	:	6.2	6
163	:	136	: :	10	:	8.3	8

Age.	Widows.	Wives.
28	L. 34.992	L. 58.410
38	63.164	52.224
48	82.170	44.030
58	99.171	32.032
68	47.400	10.216
78	42.680	3.752
	L. 369.577	L. 200.664

The amount of these sums is, L. 570.241, or L. 570, 4s. $9\frac{3}{4}$d.; and this sum, being increased in the proportion of L. 1, the annuity assumed in the Tables, to L. 2 : 16 : 3, the annuity adopted by the Society, becomes L. 1603, 16s.*, which is the present value of all the future allowances to widows. And this sum, added to the value of the other future allowances, L. 1538 : 17 : $3\frac{3}{4}$, makes the total value of all the future allowances L. 3142 : 13 : $3\frac{3}{4}$.

Next, to find the *value* of the *future contributions* of the society.

The sums in Col. 4. of Table VI. of each Scheme, opposite ages 28, 38, 48, 58, and 68, are respectively

Age.			
28	L. 17.0542	Value at that age of future contributions.	
38	15.0522	do.	do.
48	12.4106	do.	do.
58	8.6388	do.	do.
68	2.7214	do	do.

The first four of these sums being multiplied by

* L. 1 0 0 : 570 4 $9\frac{3}{4}$ :: 2 16 3 : 1603 16 0

20, and the last by 10, the number of members at those ages, we have

Age.			
28	L. 341.0840,	value of fut. contribs. of memb. at that age.	
38	301·0440,	do.	do.
48	248.2120,	do.	do.
58	172.7760,	do.	do.
68	27.2140,	do.	do.

L. 1090.3300, or L. 1090 : 6 : 7¼, the present value of all the future contributions, at the rate of the standard annual contribution of L. 1.

But as the given contribution is 12s., this sum must be reduced, by Rule 3. Art. 48., in the proportion of L. 1 to 12s.,—and it becomes L. 654, 2s. 11½d. *, which must be the present value of all the future contributions of the society.

Now, the value of the *future allowances* was found above to be L. 3142 : 13 : 3¾, and as the value of *future contributions* is found to be L. 654, 2s. 11½d.,—the difference of these sums, which is L. 2488 : 10 : 4¼, ought to be the stock of the society †, or the money in hand, necessary for fulfilling all the obligations of the society.

* L. 1 0 0 : L. 0 12 0 :: L. 1090 6 7¼ : L. 654 2 11½

† It is obvious, that if the annual contributions, instead of ceasing at 70 years of age, continue to be paid during life, as is commonly the case, the value of the future contributions will be more than what is here found; and that, if the annuity for old age do not commence at 70, but only when the member becomes actually superannuated, the present value of this al-

Problem VII.

57. If it should be thought proper to *defer* the distribution of the *Allowances* for any given number of years *after* the commencement of the *Annual Contributions*,—it is required to *determine*,

1st, To what the *allowances* in the Tables, *commencing at any given age* *, must be *increased*, in order to be equivalent to the *standard annual contribution* of the Tables.

2d, To what the *annual contributions* in the Tables, *commencing at any given age* †, must be diminished, if the *standard allowances* remain the same as in the Tables.

lowance will be somewhat less than here found.—See Appendix to the Tables.

If in a society an allowance is made for the funerals of children under 15, we may suppose 2 children's funerals for each funeral of a member.

If annuities are given to the widows arising from second marriages, without a second contribution being imposed upon the person marrying a second time, we may suppose the annuities in the tables, commencing at any age, to be diminished a fourth part on that account; and if the widow's annuity falls to the children under 12 years of age, in the event of her decease, and continues till they be of that age, we may suppose the annuities to be lessened a sixth part. Consequently, in balancing the affairs of societies, where such allowances are made, it will be necessary to increase the value of the annuities by a third part in the former case, and by a fifth in the latter.

* See Table VI. of Scheme I, II, and III.; and Table VIII. of Scheme IV. cols. 7.

† Ibid. cols. 6.

First Case.

1. To find the *increase of allowances* commencing at any age, when the allowances are deferred,

Discount, at 4 per cent. compound interest, the value of the Future Annual Contributions in the Tables, at the age when the Allowances are supposed to commence, for as many years as the Contributions are supposed to have existed previous to the Distributions.

Multiply the result by the chance of a person living, from the commencement of the Contributions, till the commencement of the Distributions, and in the case of the widows' fund, by the square of that chance. The product is the Single Contribution, payable at the commencement of the Annual Contributions, equivalent to the Allowances in the Tables, commencing at the age when the Distributions begin.*

And the Allowance commencing at that age, is just to be increased in the proportion of the Single Contribution so found, to the value of the Future Contributions in the Tables, at the age when the Annual Contributions begin†.

To illustrate this problem, by an example in the case of allowances for sickness,

Let us suppose, that the age at which the *annual contributions commence* is 26,—and that at which the distribution of *allowances begins* is 31,—and, consequently, that the contributions commence five years before the distributions:

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* See first Note at Art. 54.

† The principle of this rule, and of those in the following Problems, is the same as that of the rule in Problem IV.

Then, the value of the *future annual contributions* of L. 1 at 31 years of age, is, (Table VI. of any of the Schemes, col. 4.,) L. 16.5036, which, *discounted* for 5 years at 4 per cent., by Rule 4., Art. 49., is *reduced* to L. 13.5647 *,—and this sum, *multiplied* by 900, the number in the Mortality Table alive at 31 years of age,—and *divided* by 950, the number alive at 26, becomes L. 12.8508 †, —which is the single contribution, payable at 26,—equivalent to a weekly allowance for sickness, of L. 0.782168 (Table VI. of Scheme I., col. 7.), beginning at 31 years of age.

But, L.17.3871 is the value of the *future annual contributions* of L. 1 at 26 years of age, (Table VI. of any of the Schemes col. 4.), or the single contribution equivalent to an annual contribution of L. 1, from that age to 70;—therefore, we have this proportion:

As L. 12.8508, the single contribution found above:
To L. 17.3871, the single contribution at 26 in the Table: :
So L. 0.782168, the allowance at 31 in the Table:
To L. 1.05827, *the increased allowance required.*

Second Case.

2. To find the *diminution of the annual contribution* commencing at any age, when the allowances are deferred.

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* 1.00000 : .821927 : : 16.5036 : 13.5647.

† 13.5647 × 900 ÷ 950 = 12.8508.

Diminish the Annual Contribution in the Tables, commencing at the age when the Distributions begin, in proportion as the Allowances commencing at the same age, are less than the Allowances when increased by the former case.

Thus to take the former example, the annual contribution, commencing at 31 years of age, equivalent to the standard allowance, commencing at the same age, is L. 1.3165; and therefore we have this proportion:

As L. 1.05827, the allowance found in former case.
To L. 0 782168, the allowance at 31 in the Table::
So L. 1.31650, the annual contribution at 31 in the Table:
To L. 0.973026, *the diminished annual contribution required* *.

Problem VIII.

58. If it should be thought proper to *terminate* the *Annual Contributions* any given number of years *before* the period fixed for their termination in the Tables, while the *duration* of the *Allowances* is the same as in the Tables,—it is required to *determine*,

1*st*, To what the *allowances*, in the Tables, *commencing at any given age*, must be *diminished*, in

* As the product of the second and third terms in this proportion is always the standard allowance, it is only necessary to divide the standard allowance by the allowance found in the first case. Thus, $\frac{1.029725}{1.05827} = 0.973026$.

order to be equivalent to the *standard annual contribution* of the Tables.

2*d*, To what the *annual contribution* in the Tables, *commencing at any given age,* must be *increased,* if the *standard allowances* remain the same as in the Tables.

First Case.

1. To find the *decrease of allowances,* commencing at any age, when the duration of the contributions is shortened.

> *Discount, at 4 per cent. compound interest, the value of the Future Annual Contributions in the Tables, at the age when the Contributions are supposed to cease, for as many years as they are supposed to have continued;*
>
> *Multiply the result by the chance* * *of a person living from the commencement till the given termination of the Contributions,—and subtract the product from the value of the Future Contributions in the Tables at the age when they begin;—the remainder is the value of the reduced Future Contributions;*
>
> *And the allowance commencing at that age is just to be reduced in the proportion of the value so found to the value of the Future Contributions in the Tables.*

Thus, let us suppose that the annual contributions commence at 21 years of age, and terminate at 61, while the allowances for sickness commence at 21, and do not terminate till 71.

Then L. 7.1765, the value of the future contributions of L. 1 at 61 (Table VI. of any of the Schemes, col. 4.), discounted by Rule 4. art. 49. at 4 *per cent.*

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* See first note at Art. 54.

for 40 years, the number of years between 21 and 61, is L. 1.494786 *.

And this sum multiplied by 512, the number of living in the Mortality Table at 61,—and divided by 1000, the number of living at 21, becomes L. 0.76533 †,—which is the *single contribution* payable at 21, equivalent to the *annual contribution* of L. 1 above 60.

But L. 18.1173, is the value at 21 of *all* the future annual contributions,—and, therefore, if we subtract L. 0.76533, from that sum, we get L. 17.3520, the value at 21 of the future annual contributions of L. 1 *till* 61. The weekly allowance for sickness commencing at 21, equivalent to an annual contribution of L. 1 from 20 to 71, is L. 1.029725; and, therefore, we have this proportion:

As L. 18.1173, the value at 21 of the fut. contrib. till 71:
To L. 17.3520, the value at 21 of the fut. contrib. till 61 : :
So L. 1.029725, the allowance at 21 in the Table:
To L. 0.98623, *the decreased allowance required.*

Second Case.

To find the *increase* of the *annual contribution*, commencing at any age, when the duration of the contributions is shortened.

Increase the Annual Contribution in the Tables, commencing at the given age, in proportion as the Allowances in the Tables commencing at the same age, are greater than the Allowances when diminished by the former case.

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* 1.000000 : .208289 : : 7.1765 : 1.494786.

† 1.494786 × 512 ÷ 1000 = 0.76533.

Thus, to take the former example, we have this proportion:

As L. 0.98623, the allowance found in the former case:
To L. 1.029725, the allowance at 21 in the Table::
So L. 1.00000, the annual contrib. at 21 in the Table:
To L. 1.0441, *the increased annual contrib. required.*

Problem IX.

59. If the schemes be *altered* from those in the Tables, as supposed in the two last problems, by deferring the *Distribution of Allowances* for some years *after* the commencement of the *Contributions*,—or terminating the *Contributions* some years *before* the termination of the *Allowances*,—it is required in these cases *to determine the values at any age of the future contributions and distributions, and, consequently, the individual stocks* *.

If the annual contributions or distributions *continue*, till the age fixed in the tables for terminating them,—*to find the values, at any age, of either;*

Reduce the values of the Future Contributions and Distributions in the Tables, at that age, in proportion to the Annual Contribution or Allowance given.

But if the distributions commence at a *later* age than the contributions,—then to find the value of the *future distributions at any age betwixt the com-*

* This problem is not applicable to the Widows' Fund, in which the Stock is found in a different manner, as in Problem VI.

mencement of the contributions and distributions, we must

> *Discount, at 4 per cent. compound interest, the value of the Future Distributions in the Tables at the age when they commence (after being reduced as above), for the number of years betwixt that age andthe age when the value is sought,—and multiply the result by the chance of a person living from the one period to the other;—the product is the value required.*

And, if the contributions terminate at an *earlier* age than the allowances,—then to find the values of the *future contributions at any age,* we must

> *Discount, at 4 per cent. compound interest, the value of the Future Contributions in the Tables, at the age when the Contributions cease, for as many years as intervene betwixt that age and the age at which the value is sought;—multiply the result by the chance of a person living from the one period to the other,—and subtract the product from the value of the Contribution at the given age in the Tables;—the remainder is the value required.*

To illustrate this problem, by an example from Scheme I., let it be required to find the *individual stock at 28 years of age,*

1*st*, On the supposition, that the annual contribution of L. 1 *commences at 26 years* of age, and continues till 71; while the corresponding allowances commence at 31, and continue till the same age,

2*d*, On the supposition that the annual contribution of L. 1 begins at 21, and terminates at 61 years of age, while the corresponding allowances, beginning at 21, continue till 71 years of age.

First Case.

It was found, by case first of Problem VII., that a sum of L. 17.3871, paid at 26 years of age, which is equivalent to an annual contribution of L. 1, after that age, corresponds to an allowance for sickness of L.1.05827, *commencing at* 31;—but, by Table VI. of Scheme I., col. 5., a sum of L. 21.7270, paid at 31, is equivalent to the *standard allowance* of L.1.029725, commencing at the same age;—therefore, since L.1.029725 is to L.1.05827, as L.21.7270 is to L. 22.3293,—this last must be the sum payable at 31, equivalent to an allowance of L. 1.05827,—or must be the value, at that age, of the future allowances, when these allowances are at the rate of L. 1.05827. This sum of L. 22.3293, discounted at 4 *per cent.* for *three* years, the number of years betwixt 31 years of age, when the distributions commence, and 28 when the value is to be ascertained,—and multiplied by $\frac{900}{930}$, the chance * of a person living from 28 to 31, becomes L. 19.2104 †,—which is the *value*, at 28 years of age, of the *future allowances* of L. 1.05827, commencing at 31.

Now, the *value* of the *future contributions*, at the standard rate in the Tables, at 28 years of age, is L. 17.0542;—and, since the stock is always the difference between the *value of the future contributions* and *the value of the future allowances*,—this sum, *subtracted* from L. 19.2104, the value of the future allowances found above, leaves L. 2.1562, for the individual stock, at 28 years of age, when the

* See first note at Art. 54.

† $.888996 \times 22.3293 \times \frac{900}{930} = 19.2104.$

contributions commence at 26, and the corresponding allowances at 31.

Second Case.

The decreased allowance at 21, corresponding to the annual contribution of L. 1, when terminated at 61, was found, by case first of Problem VIII., to be L. 0.98623; therefore, since L. 1.029725, the standard allowance, is to L. 20.4899, the value of future allowances at 28 in the Tables, as L. 0.98623, is to L. 19.6244,—this last is the value of the *future allowances* of L. 0.98623, at 28 years of age.

The number of years betwixt 28 and 61 is 33, and the value of the future contributions at 61 years of age, in the Tables, is L. 7.1765. This sum, when discounted at 4 per cent. for 33 years, and multiplied by $\frac{512}{930}$, the chance* of a person living from 28 to 61, becomes L. 1.082927†; — which, subtracted from L. 17.0542, the value at 28 of the future contributions in the Tables, — leaves L. 15.9713 for the value of the future contributions, when they cease at 61 years of age.

Now, the value of the future distributions found above, was L. 19.6244, from which L. 15.9713 being subtracted, there remains L. 3.6531 for the individual stock at 28 years of age, when the annual contributions terminate at 61, and the allowances continue till 71.

* See first note at art. 54.

† L. $7.1765 \times .274094 \times \frac{512}{930} = 1.082927$.

V.

PRACTICAL TABLES.

PRACTICAL TABLES.

TABLE I.—*WEEKLY SICK ALLOWANCE*,

Shewing—The Weekly Allowances for Sickness after any given Age between 20 and 46 till 70, corresponding to the Annual Contributions under mentioned, commencing at the given age, and terminating at the end of the 70th year of age.

An Annual Contribution from the age of entry, will afford from that age the Weekly Sick Money noted under the Contribution, and opposite the Age of Entry.

Age at Entry.	Annual Contrib. £1.			Annual Contrib. 10s.			Annual Contrib. 5s.			Annual Contrib. 4s.			Annual Contrib. 2s. 6d.			Annual Contrib. 2s.			Annual Contrib. 1s.		
	Weekly Sick Money.			Weekly Sick Money.			Weekly Sick Money.			Weekly Sick Money.			Weekly Sick Money.			Weekly Sick Money.			Weekly Sick Money.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
21	1	0	7	0	10	3½	0	5	1¾	0	4	1½	0	2	6¾	0	2	0¾	0	1	0¼
22	1	0	1¼	0	10	0½	0	5	0¼	0	4	0¼	0	2	6	0	2	0	0	1	0
23	0	19	7½	0	9	9¾	0	4	10¾	0	3	11	0	2	5¼	0	1	11½	0	0	11¾
24	0	19	1½	0	9	6¾	0	4	9¼	0	3	9¾	0	2	4½	0	1	10¾	0	0	11¼
25	0	18	7½	0	9	3¾	0	4	7¾	0	3	8½	0	2	3¾	0	1	10¼	0	0	11
26	0	18	1½	0	9	0¾	0	4	6¼	0	3	7½	0	2	3	0	1	9¾	0	0	10¾
27	0	17	7½	0	8	9¾	0	4	4¾	0	3	6¼	0	2	2¼	0	1	9	0	0	10½
28	0	17	1½	0	8	6¾	0	4	3¼	0	3	5	0	2	1½	0	1	8½	0	0	10¼
29	0	16	7½	0	8	3¾	0	4	1¾	0	3	3¾	0	2	0¾	0	1	7¾	0	0	9¾
30	0	16	1½	0	8	0¾	0	4	0¼	0	3	2½	0	2	0	0	1	7¼	0	0	9½
31	0	15	7½	0	7	9¾	0	3	10¾	0	3	1½	0	1	11¼	0	1	6¾	0	0	9¼
32	0	15	1¾	0	7	6¾	0	3	9¼	0	3	0¼	0	1	10½	0	1	6	0	0	9
33	0	14	7¾	0	7	3¾	0	3	7¾	0	2	11	0	1	9¾	0	1	5½	0	0	8¾
34	0	14	1¾	0	7	0¾	0	3	6¼	0	2	9¾	0	1	9	0	1	4¾	0	0	8¼
35	0	13	8	0	6	10	0	3	5	0	2	8¾	0	1	8½	0	1	4¼	0	0	8
36	0	13	2¼	0	6	7	0	3	3½	0	2	7½	0	1	7¾	0	1	3¾	0	0	7¾
37	0	12	8½	0	6	4¼	0	3	2	0	2	6½	0	1	7	0	1	3¼	0	0	7½
38	0	12	2¾	0	6	1¼	0	3	0½	0	2	5¼	0	1	6¼	0	1	2½	0	0	7¼
39	0	11	9¼	0	5	10½	0	2	11¼	0	2	4¼	0	1	5½	0	1	2	0	0	7
40	0	11	3½	0	5	7¾	0	2	9¾	0	2	3	0	1	4¾	0	1	1½	0	0	6¾
41	0	10	10¼	0	5	5	0	2	8½	0	2	2	0	1	4¼	0	1	1	0	0	6½
42	0	10	4¾	0	5	2¼	0	2	7	0	2	0¾	0	1	3½	0	1	0¼	0	0	6
43	0	9	11½	0	4	11¾	0	2	5¾	0	1	11¾	0	1	2¾	0	0	11¾	0	0	5¾
44	0	9	6½	0	4	9¼	0	2	4½	0	1	10¾	0	1	2¼	0	0	11¼	0	0	5½
45	0	9	1½	0	4	6¾	0	2	3¼	0	1	9¾	0	1	1½	0	0	10¾	0	0	5¼

EXAMPLE.—An Entrant at 28 years of age, contributing 4s. annually from that age during life till completing his 70th year, is entitled to 3s. 5d. of weekly sick money for the same period.

TABLE II.—*ANNUITY FOR OLD AGE,*

Shewing—The Annuities for Life after 70 years of age, corresponding to the Annual Contributions under mentioned, commencing at any given age between 20 and 46, and terminating at the end of the 70th year of age.

An Annual Contribution from the Age of Entry will afford the Annuity during Life after 70 years of age, noted under the Annual Contribution, opposite the age of Entry.

Age at Entry.	Annual Contrib. £1.			Annual Contrib. 10s.			Annual Contrib. 5s.			Annual Contrib. 4s.			Annual Contrib. 2s. 6d.			Annual Contrib. 2s.			Annual Contrib. 1s.		
	Annuity.			Annuity.			Annuity.			Annuity.			Annuity.			Annuity.			Annuity.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
21	58	0	2½	29	0	1¼	14	10	0½	11	12	0½	7	5	0¼	5	16	0¼	2	18	0
22	54	16	2	27	8	1	13	14	0½	10	19	2¾	6	17	0¼	5	9	7¼	2	14	9½
23	51	15	2½	25	17	7¼	12	18	9½	10	7	0½	6	9	4¾	5	3	6¼	2	11	9
24	48	17	2¼	24	8	7	12	4	3½	9	15	5¼	6	2	1¾	4	17	8½	2	8	10¼
25	46	1	11½	23	0	11¾	11	10	5¾	9	4	4½	5	15	2¾	4	12	2¼	2	6	1
26	43	9	5	21	14	8½	10	17	4¼	8	13	10½	5	8	8	4	6	11¼	2	3	5½
27	40	19	5	20	9	8½	10	4	10¼	8	3	10½	5	2	5	4	1	11¼	2	0	11½
28	38	11	10	19	5	11	9	12	11½	7	14	4¼	4	16	5¾	3	17	2	1	18	7
29	36	6	7	18	3	3½	9	1	7¾	7	5	3¾	4	10	9¾	3	12	7¾	1	16	3¾
30	34	3	6¼	17	1	9	8	10	10½	6	16	8¼	4	5	5¼	3	8	4	1	14	2
31	32	2	7	16	1	3½	8	0	7¾	6	8	6	4	0	3¾	3	4	3	1	12	1½
32	30	3	7¾	15	1	9¾	7	10	10¾	6	0	8¾	3	15	5¼	3	0	4¼	1	10	2
33	28	6	7½	14	3	3¾	7	1	7¾	5	13	3¾	3	10	9¾	2	16	7¾	1	8	3¾
34	26	11	5½	13	5	8¾	6	12	10¼	5	6	3½	3	6	5	2	13	1¾	1	6	6¾
35	24	18	1	12	9	0½	6	4	6¼	4	19	7¼	3	2	3	2	9	9½	1	4	10¾
36	23	6	4½	11	13	2¼	5	16	7	4	13	3¼	2	18	3½	2	6	7½	1	3	3¾
37	21	16	3½	10	18	1¾	5	9	0¾	4	7	3	2	14	6¼	2	3	7½	1	1	9¾
38	20	7	9	10	3	10½	5	1	11¼	4	1	6½	2	10	11½	2	0	9¼	1	0	4½
39	19	0	8	9	10	4	4	15	2	3	16	1½	2	7	7	1	18	0¾	0	19	0¼
40	17	15	0	8	17	6	4	8	9	3	11	0	2	4	4½	1	15	6	0	17	9
41	16	10	8¼	8	5	4	4	2	8	3	6	1½	2	1	4	1	13	0¾	0	16	6¼
42	15	7	7¾	7	13	9¾	3	16	10¾	3	1	6¼	1	18	5¼	1	10	9	0	15	4½
43	14	5	10	7	2	11	3	11	5½	2	17	2	1	15	8¾	1	8	7	0	14	3½
44	13	5	2¼	6	12	7	3	6	3½	2	13	0¼	1	13	1¾	1	6	6	0	13	3
45	12	5	8	6	2	10	3	1	5	2	9	1½	1	10	8½	1	4	6¾	0	12	3¼

EXAMPLE.—An Entrant at 26 years of age, contributing 2s. 6d. annually from that age during life till completing his 70th year, is entitled to £5 : 8 : 8 per annum during life after 70.

TABLE III.—*FUNERAL ALLOWANCE*,

Shewing—The Allowances payable at Death for Funerals, or other purposes, corresponding to the Annual Contributions under mentioned, commencing at any given age between 20 and 46, and terminating at the end of the 70th year of age.

An Annual Contribution from the Age of Entry will afford, at the Death of each Member, the sum noted under the Annual Contribution, opposite the Age of Entry.

Age at Entry.	Annual Contrib. £1. Funeral Money.			Annual Contrib. 10s. Funeral Money.			Annual Contrib. 5s. Funeral Money.			Annual Contrib. 4s. Funeral Money.			Annual Contrib. 2s. 6d. Funeral Money.			Annual Contrib. 2s. Funeral Money.			Annual Contrib. 1s. Funeral Money.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
21	59	19	2	29	19	7	14	19	9½	11	19	10	7	9	10¾	5	19	11	2	19	11½
22	58	11	9	29	5	10½	14	12	11¼	11	14	4	7	6	5½	5	17	2	2	18	7
23	57	4	3	28	12	1½	14	6	0¾	11	8	10	7	3	0¼	5	14	5	2	17	2½
24	55	16	7¾	27	18	3¾	13	19	1¾	11	3	3¾	6	19	6¾	5	11	7¾	2	15	9¾
25	54	8	11½	27	4	5¾	13	12	2¾	10	17	9½	6	16	1¼	5	8	10¾	2	14	5¼
26	53	1	2½	26	10	7¼	13	5	3½	10	12	2¾	6	12	7¾	5	6	1¼	2	13	0½
27	51	13	4	25	16	8	12	18	4	10	6	8	6	9	2	5	3	4	2	11	8
28	50	5	5½	25	2	8¾	12	11	4¼	10	1	1	6	5	8	5	0	6½	2	10	3¼
29	48	17	5¾	24	8	8¾	12	4	4¼	9	15	5¾	6	2	2	4	17	8¾	2	8	10¼
30	47	9	5½	23	14	8¾	11	17	4¼	9	9	10½	5	18	8	4	14	11¼	2	7	5½
31	46	1	4½	23	0	8¼	11	10	4	9	4	3¼	5	15	2	4	12	1½	2	6	0¾
32	44	13	3	22	6	7½	11	3	3¾	8	18	7¾	5	11	7¾	4	9	3¾	2	4	7¾
33	43	7	10	21	13	11	10	16	11½	8	13	6¾	5	8	5¾	4	6	9¼	2	3	4½
34	42	2	4½	21	1	2¼	10	10	7	8	8	5½	5	5	3½	4	4	2¾	2	2	1¼
35	40	16	10¼	20	8	5	10	4	2½	8	3	4¼	5	2	1¼	4	1	8	2	0	10
36	39	11	3¼	19	15	7½	9	17	9¾	7	18	3	4	18	10¾	3	19	1½	1	19	6¾
37	38	5	7¾	19	2	9¾	9	11	4¾	7	13	1½	4	15	8¼	3	16	6¾	1	18	3¼
38	36	19	11½	18	9	11¾	9	4	11¾	7	7	11¾	4	12	5¾	3	13	11¾	1	16	11¾
39	35	14	2¾	17	17	1¼	8	18	6½	7	2	10	4	9	3¼	3	11	5	1	15	8½
40	34	10	7¾	17	5	3¾	8	12	7¾	6	18	1½	4	6	3¾	3	9	0¾	1	14	6¼
41	33	7	0	16	13	6	8	6	9	6	13	4¾	4	3	4½	3	6	8¼	1	13	4
42	32	3	3¾	16	1	7¾	8	0	9¾	6	8	7¾	4	0	4¾	3	4	3¾	1	12	1¾
43	30	19	6¾	15	9	9¼	7	14	10½	6	3	10¾	3	17	5¼	3	1	11¼	1	10	11½
44	29	15	9	14	17	10½	7	8	11¼	5	19	1¾	3	14	5½	2	19	6¾	1	9	9¼
45	28	11	10½	14	5	11¼	7	2	11½	5	14	4½	3	11	5¾	2	17	2¼	1	8	7

Example.—An Entrant at 27 years of age, contributing 2s. annually from that age during life till completing his 70th year, can, at whatever period he dies, secure a sum of £5 : 3 : 4, payable at his death, for Funeral-expences or other purposes.

Nota.—If a similar provision of like amount is desired for the Funeral of a Member's Wife or Widow, the Annual Contribution should be doubled.

TABLE IV.—*WIDOWS' ANNUITY*,

Shewing,—The Annuities for Life to a Woman, after the death of her Husband, corresponding to the Annual Contributions under mentioned, commencing at any age between 20 and 46, and terminating at the end of the 70th year of age.

An Annual Contribution from the Age of Entry, will afford the Annuity for Life to the Widow noted under the Annual Contribution, opposite the Age of Entry.

Age at Entry.	Annual Contrib. £1.			Annual Contrib. 10s.			Annual Contrib. 5s.			Annual Contrib. 4s.			Annual Contrib. 2s. 6d.			Annual Contrib. 2s.			Annual Contrib. 1s.		
	Widow's Annuity.			Widow's Annuity.			Widow's Annuity.			Widow's Annuity.			Widow's Annuity.			Widow's Annuity.			Widow's Annuity.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
21	5	12	6½	2	16	3¼	1	8	1½	1	2	6	0	14	0¾	0	11	3	0	5	7½
22	5	11	7¼	2	15	9½	1	7	10¾	1	2	3¾	0	13	11¼	0	11	1¾	0	5	6¾
23	5	10	7¾	2	15	3¾	1	7	7¾	1	2	1½	0	13	9¾	0	11	0¾	0	5	6¼
24	5	9	7¾	2	14	9¾	1	7	4¾	1	1	11	0	13	8¼	0	10	11½	0	5	5¾
25	5	8	6¾	2	14	3¼	1	7	1½	1	1	8½	0	13	6¾	0	10	10¼	0	5	5
26	5	7	5¾	2	13	8¾	1	6	10¼	1	1	5¾	0	13	5	0	10	8¾	0	5	4¼
27	5	6	3¾	2	13	1¾	1	6	6¾	1	1	3	0	13	3¼	0	10	7½	0	5	3¾
28	5	5	1½	2	12	6¾	1	6	3¼	1	1	0¼	0	13	1¾	0	10	6	0	5	3
29	5	3	10¼	2	11	11	1	5	11½	1	0	9¼	0	12	11¾	0	10	4½	0	5	2¼
30	5	2	6½	2	11	3¼	1	5	7½	1	0	6	0	12	9¾	0	10	3	0	5	1½
31	5	1	2	2	10	7	1	5	3½	1	0	2¾	0	12	7¾	0	10	1¼	0	5	0½
32	4	19	8	2	9	10	1	4	11	0	19	11	0	12	5½	0	9	11½	0	4	11¾
33	4	18	7	2	9	3½	1	4	7¾	0	19	8½	0	12	3¾	0	9	10¼	0	4	11
34	4	17	5½	2	8	8¾	1	4	4¼	0	19	5¾	0	12	2	0	9	8¾	0	4	10¼
35	4	16	3	2	8	1½	1	4	0¾	0	19	3	0	12	0¼	0	9	7½	0	4	9¾
36	4	15	0	2	7	6	1	3	9	0	19	0	0	11	10½	0	9	6	0	4	9
37	4	13	7¾	2	6	9¾	1	3	4¾	0	18	8¾	0	11	8¼	0	9	4¼	0	4	8
38	4	12	2¾	2	6	1¼	1	3	0½	0	18	5¼	0	11	6¼	0	9	2¾	0	4	7¼
39	4	11	2¼	2	5	7	1	2	9½	0	18	2¾	0	11	4¾	0	9	1¼	0	4	6¼
40	4	10	0½	2	5	0¼	1	2	6	0	18	0	0	11	3	0	9	0	0	4	6
41	4	8	10	2	4	5	1	2	2½	0	17	9	0	11	1¼	0	8	10½	0	4	5¼
42	4	7	6¼	2	3	9	1	1	10½	0	17	6	0	10	11¼	0	8	9	0	4	4½
43	4	6	2	2	3	1	1	1	6½	0	17	2¾	0	10	9¼	0	8	7¼	0	4	3½
44	4	4	8¼	2	2	4	1	1	2	0	16	11¼	0	10	7	0	8	5½	0	4	2¾
45	4	3	1½	2	1	6¾	1	0	9¼	0	16	7½	0	10	4½	0	8	3¾	0	4	1¾

Example.—An Entrant at 32 years of age, contributing 5s. annually from that age during life till completing his 70th year, can, at whatever period he dies, secure to his widow a sum of £ 1 : 4 : 11 per annum during her life, to commence at his death.

TABLE V.

5s. *Weekly Sick Allowance.*

Shewing what Annual Contribution, commencing at any given age between 20 and 46, and continuing till 70, is required for an allowance of 5s. for each week of Sickness during the period of Contribution.

Age.	Contribution.			Age.	Contribution.			Age.	Contribution.			Age.	Contribution.			Age.	Contribution.		
	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
21	0	4	10	26	0	5	6	31	0	6	4½	36	0	7	7	41	0	9	2½
22	0	4	11½	27	0	5	8	32	0	6	7	37	0	7	10½	42	0	9	7¼
23	0	5	1	28	0	5	10	33	0	6	9¾	38	0	8	2	43	0	10	0¼
24	0	5	2¾	29	0	6	0	34	0	7	0¾	39	0	8	5¾	44	0	10	5¾
25	0	5	4¼	30	0	6	2¼	35	0	7	3½	40	0	8	10	45	0	10	11½

Example.—To an Entrant at the age of 29, a weekly sick allowance of 5s, from that age till completing his 70th year, will require an Annual Contribution of 6s. during the same period, if he live so long.

TABLE VI.

£5 *Annuity for Old Age.*

Shewing what Annual Contribution, commencing at any given age, between 20 and 46, and continuing till 70, is required for an annuity of £5 for life after 70.

Age.	Contribution.			Age.	Contribution.			Age.	Contribution.			Age.	Contribution.			Age.	Contribution.		
	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
21	0	1	8¾	26	0	2	3½	31	0	3	1¼	36	0	4	3	41	0	6	0½
22	0	1	9¾	27	0	2	5¼	32	0	3	3½	37	0	4	7	42	0	6	6
23	0	1	11	28	0	2	7	33	0	3	6¼	38	0	4	10¾	43	0	7	0
24	0	2	0½	29	0	2	9	34	0	3	9	39	0	5	3	44	0	7	6½
25	0	2	2	30	0	2	11	35	0	4	0	40	0	5	7½	45	0	8	1¾

Example.—To an Entrant at the age of 35, an Annuity of £5 for life after 70, will require an Annual Contribution of 4s. from the age of entry till completing his 70th year, if he live so long.

TABLE VII.

£ 5 Funeral Money.

Shewing what Annual Contribution, commencing at any given age between 20 and 46, and continuing till 70, is required for an Allowance of £5 to defray the Funeral Expenses of a Member.

Age.	Contribution. £	s.	d.	Age.	Contribution. £	s.	d.	Age.	Contribution. £	s.	d.	Age.	Contribution. £	s.	d.	Age.	Contribution. £	s.	d.
21	0	1	8	26	0	1	10½	31	0	2	2	36	0	2	6½	41	0	3	0
22	0	1	8½	27	0	1	11	32	0	2	2¾	37	0	2	7½	42	0	3	1¼
23	0	1	9	28	0	1	11¾	33	0	2	3½	38	0	2	8½	43	0	3	2¾
24	0	1	9½	29	0	2	0½	34	0	2	4½	39	0	2	9½	44	0	3	4¼
25	0	1	10	30	0	2	1¼	35	0	2	5½	40	0	2	10¾	45	0	3	6

Example.—To an Entrant at the age of 41, an allowance of £5 at his death will require an Annual Contribution of 3s. from the age of entry till completing his 70th year, if he live so long.

If the Funeral Expenses of a Member's Wife are also to be provided for to the same amount, the Contribution must be doubled.

TABLE VIII.

£ 5 Widow's Annuity.

Shewing what Annual Contribution, commencing at any given age between 20 and 46, and continuing till 70, is required for an annuity of £5 for life to the Widow.

Age.	Contribution. £	s.	d.	Age.	Contribution. £	s.	d.	Age.	Contribution. £	s.	d.	Age.	Contribution. £	s.	d.	Age.	Contribution. £	s.	d.
21	0	17	9¼	26	0	18	7¼	31	0	19	9¼	36	1	1	0½	41	1	2	6
22	0	17	11	27	0	18	9½	32	1	0	0¾	37	1	1	4¼	42	1	2	10
23	0	18	1	28	0	19	0	33	1	0	3	38	1	1	8	43	1	3	2½
24	0	18	2¾	29	0	19	2¾	34	1	0	6	39	1	1	11	44	1	3	7[illegible]
25	0	18	4¾	30	0	19	5¾	35	1	0	9¼	40	1	2	2½	45	1	4	0[illegible]

Example.—To an Entrant at the age of 42, an Annuity of £5 for life to his widow, will require an Annual Contribution of £1 : 2 . 10 from the age of entry till completing his 70th year, if he live so long.

TABLE IX.

Of £1 Entry Money Equivalents;

Shewing what Annual Contribution, commencing at any given age, between 20 and 46, and continuing till 70, is equivalent to a Single Contribution, or Entry-money, of £1 at the given age.

Age.	Contribution.			Age.	Contribution.			Age.	Contribution.			Age.	Contribution.			Age.	Contribution.		
	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
21	0	1	1¼	26	0	1	1¾	31	0	1	2½	36	0	1	3½	41	0	1	4¾
22	0	1	1¼	27	0	1	2	32	0	1	2½	37	0	1	3¾	42	0	1	5
23	0	1	1½	28	0	1	2	33	0	1	2¾	38	0	1	4	43	0	1	5¼
24	0	1	1½	29	0	1	2¼	34	0	1	3	39	0	1	4¼	44	0	1	5½
25	0	1	1¾	30	0	1	2¼	35	0	1	3¼	40	0	1	4½	45	0	1	6

EXAMPLE.—To an Entrant at the age of 28, £1 of Entry-money will be equivalent to an Annual Contribution of 1s. 2d. from that age till completing his 70th year, if he live so long.

DEFERRED ALLOWANCES.

TABLE X.

Shewing to what the Annual Contribution of £1, commencing at any age between 20 and 46, and continuing till 70, is reduced, in order to be equivalent to the Allowances in the Tables, corresponding to an Annual Contribution of £1, when they commence 3 years later than the given Age.

Age.	Contribution.			Age.	Contribution.			Age.	Contribution.			Age.	Contribution.			Age.	Contribution.		
	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
21	0	16	10	26	0	16	8½	31	0	16	6½	36	0	16	3¾	41	0	16	0½
22	0	16	9¾	27	0	16	8¼	32	0	16	6	37	0	16	3¼	42	0	15	11¾
23	0	16	9½	28	0	16	7¾	33	0	16	5½	38	0	16	2½	43	0	15	10¾
24	0	16	9¼	29	0	16	7½	34	0	16	5	39	0	16	2	44	0	15	9¾
25	0	16	9	30	0	16	7	35	0	16	4½	40	0	16	1¼	45	0	15	8½

In the case of Allowances to Widows, the above Contributions are diminished 6d. at 21 years of age, and this diminution gradually increases to 9d. at 45 years of age.

EXAMPLE.—An Entrant at the age of 21, contributing annually 16s. 10d. for each allowance from that age till completing his 70th year, if he live so long, but receiving no allowances during 3 years after entry, is entitled, if he survive that period, to the allowances in the Practical Tables I. II. and III. corresponding to an Annual Contribution of £1, opposite the age of 24, viz. 19s. 1½d., £48 : 17 : 2¼, and £55 : 16 : 7¾; and by contributing 6d. less, or 16s. 4d., his Widow is entitled to the allowance in Table IV., £5 : 9 : 7¾. If he dies within the 3 years, no allowances are payable.

TABLE XI.

Shewing to what the Weekly Allowances for Sickness, commencing at any age between 23 and 46, and continuing till 70, are increased, in order to be equivalent to the Annual Contribution of £1, commencing 3 years previous to the given Age, and continuing till 70.

Age.	Distribution.			Age.	Distribution.			Age.	Distribution.			Age.	Distribution.			Age.	Distribution.		
	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
21				26	1	1	7¼	31	0	18	9½	36	0	16	0½	41	0	13	4½
22				27	1	1	0½	32	0	18	2¼	37	0	15	6	42	0	12	10½
23				28	1	0	5¼	33	0	17	8	38	0	14	11½	43	0	12	4½
24	1	2	8¾	29	0	19	11	34	0	17	1½	39	0	14	5	44	0	11	10¾
25	1	2	2	30	0	19	4¼	35	0	16	7	40	0	13	10¾	45	0	11	5¼

Example.—An Entrant at the age of 26, contributing annually £1 from that age till completing his 70th year, if he live so long, but receiving no allowances during 3 years after entry, is entitled, if he survive that period, to a Weekly Sick Allowance of 19s. 11d., the sum opposite age 29 in this Table, from that age till 70.

TABLE XII.

Shewing to what the Funeral Allowances, commencing at any age between 23 and 46, are increased, in order to be equivalent to the Annual Contribution of £1, commencing 3 years previous to the given age, and continuing till 70.

Age.	Distribution.			Age.	Distribution.			Age.	Distribution.			Age.	Distribution.			Age.	Distribution.		
	£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.		£	s.	d.
21				26	63	3	6	31	55	6	9½	36	48	1	5¼	41	41	2	3
22				27	61	12	3	32	53	15	0½	37	46	12	9½	42	39	15	9½
23				28	60	0	11¾	33	52	6	8¾	38	45	4	0½	43	38	9	4
24	66	5	9½	29	58	9	8	34	50	18	5	39	43	15	1	44	37	2	10
25	64	14	8	30	56	18	3½	35	49	10	0	40	42	8	8¼	45	35	16	2¼

Example.—An Entrant at the age of 31, contributing annually £1 from that age till completing his 70th year, if he live so long, entitles his family at his death, at whatever period it happens, provided he survive 3 years after entry, to £50 : 18 : 5, the sum opposite age 34 in this Table; but if he dies within that period, his family is debarred from any claim.

TABLE XIII.

Shewing to what the Annuities for Widows, commencing at any age between 23 and 46, are increased, in order to be equivalent to the Annual Contribution of £1, commencing 3 years previous to the given Age, and continuing till 70.

Age.	Distribution. £	s.	d.	Age.	Distribution. £	s.	d.	Age.	Distribution. £	s.	d.	Age.	Distribution. £	s.	d.	Age.	Distribution. £	s.	d.
21				26	6	11	10¼	31	6	5	8	36	6	0	1¼	41	5	14	4
22				27	6	10	9	32	6	4	1¼	37	5	18	8¼	42	5	13	2¾
23				28	6	9	7¼	33	6	3	2¾	38	5	17	3¾	43	5	12	0½
24	6	14	2½	29	6	8	4½	34	6	2	3¼	39	5	16	5¼	44	5	10	8½
25	6	13	0½	30	6	7	0¾	35	6	1	2½	40	5	15	5¼	45	5	9	2¾

EXAMPLE.—An Entrant at the age of 41, contributing annually £1 from that age till completing his 70th year, if he live so long, entitles his Widow at his death, at whatever period it happens, provided he survive 3 years after entry, to an Annuity for life of £5 : 10 : 8½, the sum opposite age 44 in this Table; but if he dies within that period, his Widow has no claim for any Annuity.

APPENDIX

TO

THE TABLES.

60. In the preceding Schemes, we supposed the Annual Contributions to cease in the 70th year of age, if the life did not fail before that time, on account of the difficulty felt by members of Friendly Societies in paying their Contributions after that age; but, if we had supposed the Annual Contributions to continue during life, even after 70 years of age, we should have had, instead of the values of *Future Contributions* in Column 4. of Table VI. of each Scheme, the values of *Future Contributions* in Column 2. of Table VII. of Scheme IV.

61. We supposed also, that the allowances for sickness terminated at the end of the 70th year of age, and became an annuity for life after that age. This was done, because we had no certain data for ascertaining the number of weeks of inability to work above 70. But if we had supposed the sickness or inability to work to increase at the same accelerated rate after 70, as during the few years before it, till complete superannuation, and had provided a weekly allowance for the whole of it, we should have had, instead of the values of the *Future Allowances* in Column 5. of Table VI. of Schemes I. and II., the following

TABLE,

Shewing the Value, at any age above 20, of an Annual Distribution of L. 0·7213372, or 14s. 5d. for each week of Inability to work during life after that age.

Age.	Value of Future Distrib.	Age.	Value of Future Distrib.	Age.	Value of Future Distrib.	Age.	Value of Future Distrib.	Age.	Value of Future Distrib.
21	£18·4296	36	£29·1632	51	£51·8193	66	£102·5126	81	£173·4661
22	18·9246	37	30·2063	52	53·9462	67	107·6848	82	163·5652
23	19·4459	38	31·3003	53	56·1633	68	113·2217	83	155·5196
24	19·9942	39	32·4868	54	58·4781	69	118·6768	84	146·3839
25	20·5702	40	33·7319	55	60·8998	70	124·4182	85	137·7708
26	21·1747	41	35·0381	56	63·5451	71	130·2855	86	130·1722
27	21·8086	42	36·4059	57	66·3346	72	136·3651	87	120·9814
28	22·4729	43	37·8365	58	69·2814	73	142·7919	88	112·3588
29	23·1686	44	39·3286	59	72·5331	74	149·0847	89	104·9075
30	23·8967	45	40·8773	60	75·9967	75	155·0607	90	93·2799
31	24·6577	46	42·5380	61	79·6915	76	161·2240	91	86·8008
32	25·4534	47	44·2567	62	83·6168	77	167·6072	92	73·0413
33	26·3160	48	46·0340	63	87·9224	78	172·1814	93	64·4334
34	27·2201	49	47·8734	64	92·5932	79	176·1166	94	55·7338
35	28·1685	50	49·7746	65	97·3211	80	176·2063	95	37·6386

The sum L. 0·7213372 is the allowance found to be equivalent to an annual contribution of L. 1, commencing in the 21st year of age, and continuing during life; and therefore, if we wish to compare this allowance with those found in the Tables, we must recollect, that an annual contribution of L. 2 from 20 to 70, was equivalent to an allowance of L. 1 : 0 : 7 for each week of inability to work during this period, and also an annuity of L. 58 : 0 : 2, or a weekly allowance of L. 1 : 2 : $2\frac{3}{4}$ during the rest of life. Whereas, by the above Table, it appears, that an annual contribution of L. 2 from 20 during life, is equivalent, on the above supposition, to an allowance of L. 1·4426744, or L. 1 : 8 : 10 for each week of inability to work during the same period.

62. If we had supposed the *quantum* of sickness to continue uniform during each period of 10 years, and only to receive an increase every 10th year, as the *Returns* only show, the value of the future sick allowances at 21 years of age would have been considerably more than what was found in the Tables of Scheme I., where the sickness receives an increase every year; or, in other words, the allowance which an annual contribution of L. 1 could afford, would have been considerably less.

63. We shall here calculate the values, upon this supposition, by our Annuity Table, Column 2. of Table VII. of Scheme IV., in order to compare them with the same values calculated by the Northampton and Carlisle Tables of Annuities.

The rate of sickness given by the Returns, was,

From 20 to 30,	0·5916	weeks of sickness;			
30 to 40,	0·6865	do.	do.	or 0·0949	of increase;
40 to 50,	1·0273	do.	do.	or 0·3408	do.
50 to 60,	1·8806	do.	do.	or 0·8533	do.
60 to 70,	5·6337	do.	do.	or 3·7531	do.

Now, if we suppose, that the allowance for sickness of every kind is L. 1 per week, we have only to *find the value at 20 years of age*,

of an annuity of L. 0·5916	from 20 to 30	years of age;
of an annuity of L. 0·6865	30 to 40	do.
of an annuity of L. 1·0273	40 to 50	do.
of an annuity of L. 1·8806	50 to 60	do.
of an annuity of L. 5·6337	60 to 70	do.

Add these values together, and the amount is the value at 20 of the allowance required.

Or, as the increase of sickness from the 1st to the 2d decade of years is - 0·0949 parts of a week;
from the 2d to the 3d, 0·3400 do.
from the 3d to the 4th, 0·8533 do.
from the 4th to the 5th, 3·7531 weeks.

we may *find the value at* 20

of an annuity of L. 0·5916 from 20 to 70 years of age;
of an annuity of L. 0 0949 from 30 to 70 do.
of an annuity of L. 0·3408 from 40 to 70 do.
of an annuity of L. 0·8533 from 50 to 70 do.
of an annuity of L. 3·7531 from 60 to 70 do.

and add the sums together.

Or, we may *find the values of the same annuities for life, and from the sum of them deduct the value at* 20 *of an annuity of* L. 5·6337 *from* 70 *during the remainder of life.*

64. As this last method is the shortest, we shall make the calculations by it. In these calculations, the numbers in

Column 1. express the values of annuities of £1 on lives at the middle of the ages opposite;
Column 2. express the increments of sickness at the beginning of each ten years, or the sums found by multiplying these increments by £1;
Column 3. express the chances of living from the middle of the 21st year of age to that of the ages opposite;
Column 4. express the present values of L. 1 payable at the end of 0, 10, 20, 30, 40 and 50 years, or L. 1 discounted at 4 per cent. for these numbers of years;
Column 5. express the products of the numbers in the preceding columns, and denote the values, at the middle of the 21st year of age, of annuities of the

sums stated in Column 2., commencing at the middle of the ages opposite, and continuing during life.

According to our Table *,

Age.	1.	2.	3.	4.	5.
21,	$18{\cdot}4296 \times$	$0{\cdot}5916 \times$	$\frac{1000}{1000} \times$	$1{\cdot}000000 =$	$10{\cdot}902951$
31,	$17{\cdot}0172 \times$	$0{\cdot}0949 \times$	$\frac{900}{1000} \times$	$0{\cdot}675564 =$	$0{\cdot}981891$
41,	$15{\cdot}2270 \times$	$0{\cdot}3408 \times$	$\frac{788}{1000} \times$	$0{\cdot}456387 =$	$1\ 866265$
51,	$12{\cdot}9567 \times$	$0{\cdot}8533 \times$	$\frac{661}{1000} \times$	$0{\cdot}308319 =$	$2{\cdot}253193$
61,	$10{\cdot}1050 \times$	$3{\cdot}7531 \times$	$\frac{512}{1000} \times$	$0{\cdot}208289 =$	$4{\cdot}044480$
					$20{\cdot}048780$
71,	$7{\cdot}09096 \times$	$5{\cdot}6337 \times$	$\frac{313}{1000} \times$	$0{\cdot}140713$	$= 1{\cdot}759451$
					$18{\cdot}289329$

According to the Northampton Table,

21,	$16\ 973† \times$	$0{\cdot}5916 \times$	$\frac{5096}{5096} \times$	$1{\cdot}000000 =$	$10{\cdot}041227$
31,	$15{\cdot}710 \times$	$0{\cdot}0949 \times$	$\frac{4348}{5096} \times$	$0{\cdot}675564 =$	$0{\cdot}859348$
41,	$14{\cdot}108 \times$	$0{\cdot}3408 \times$	$\frac{3597}{5096} \times$	$0{\cdot}456387 =$	$1{\cdot}548850$
51,	$12{\cdot}161 \times$	$0{\cdot}8533 \times$	$\frac{2817}{5096} \times$	$0{\cdot}308319 =$	$1{\cdot}768596$
61,	$9{\cdot}917 \times$	$3{\cdot}7531 \times$	$\frac{1997}{5096} \times$	$0{\cdot}208289 =$	$3{\cdot}037984$
					$17{\cdot}256005$
71,	$7{\cdot}218 \times$	$5{\cdot}6337 \times$	$\frac{1192}{5096} \times$	$0{\cdot}140713 =$	$1{\cdot}338418$
					$15{\cdot}917587$

* See Art. 63. † See Note at Art. 41.

According to the Carlisle Table,

Age.	1.		2.		3.		4.		5.
21,	19·298	×	0·5916	×	$\frac{6069}{6069}$	×	1·000000	=	11·416697
31,	17·779	×	0·0949	×	$\frac{5614}{6069}$	×	0·675564	=	1·054375
41,	15·979	×	0·3408	×	$\frac{5042}{6069}$	×	0·456387	=	2·064753
51,	13·718	×	0·8533	×	$\frac{4368}{6069}$	×	0·308319	=	2·597517
61,	10·531	×	3·7531	×	$\frac{3582}{6069}$	×	0·208289	=	4·858862
									21·992204
71,	7·534	×	5·6337	×	$\frac{2339}{6069}$	×	0·140713	=	2·301795
									19·690409

Thus, the value, at the middle of the 21st year of age, of an allowance of L. 1 for each week of sickness from the middle of the 21st to the middle of the 71st year of age, if the *quantum* of sickness do not vary during each 10 years, will be,

By our Table,

L. 18·289329, or L. 18 5 9¼;

By the Northampton Table,

L. 15·917587, or L. 15 18 4;

By the Carlisle Table,

L. 19·690409, or L. 19 13 9½.

65. Also, the value at the middle of the 21st year of age of an annuity of L. 1 for life after the middle of the 71st year of age, will be,

By our Table,

Age.	1.	2.	3.	4.	5.

$$71, \quad 7.09096 \times 1. \times \frac{313}{1000} \times .140713 = .312308, \text{ or 6s. 3d;}$$

By the Northampton Table,

$$71, \quad 7{\cdot}218 \times 1. \times \frac{1192}{5096} \times {\cdot}140713 = {\cdot}237573, \text{ or 4s. 9d;}$$

By the Carlisle Table,

$$71, \quad 7{\cdot}534 \times 1. \times \frac{2339}{6069} \times {\cdot}140713 = {\cdot}408576, \text{ or 8s. 2d.}$$

Now, *the value at the middle of the 21st year of age, of an annual contribution or annuity of L. 1, commencing at that age and continuing for 50 years, unless the life fail before that time, will be equal to the value at the middle of the 21st year of age of an annuity of L. 1, for life, diminished by the value at the middle of the 21st year of age of an annuity of L. 1 for life, commencing at the middle of the 71st year of age*; and therefore is,

By our Table,

$18{\cdot}4296 - 0{\cdot}3123 = 18{\cdot}1173$, or L. 18 2 4;

By the Northampton Table,

$16{\cdot}973 - 0{\cdot}238 = 16{\cdot}735$, or L. 16 14 $8\frac{1}{2}$;

By the Carlisle Table,

$19{\cdot}298 - 0{\cdot}409 = 18{\cdot}889$, or L. 18 17 $9\frac{1}{4}$.

66. Having thus found the value, at the middle of the 21st year of age, of an annual contribution of L. 1 from that age till the middle of the 71st year, and having found above the value, at the same age, of an allowance of L. 1 for each week of sickness from 20 to 70, and of an annuity of L. 1 after that age,—we can determine what allowance for

sickness, and what annuity for old age, such annual contribution will afford; for we have only to *diminish or increase the assumed allowance and annuity, in proportion as the value of the allowance and annuity is greater or less than the value of the contribution.*

Thus, the weekly allowance will be,

By our Table,

18·289329 : 1 : : 18·1173 : 0·990594, or L. 0 19 $9\frac{1}{2}$;

By the Northampton Table,

15·917587 : 1 : : 16·735 : 1 0513522, or L. 1 1 $0\frac{1}{4}$;

By the Carlisle Table,

19·690409 : 1 : : 18·889 : 0 9592995, or L. 0 19 $2\frac{1}{2}$.

The annuity above 70 will be,

By our Table,

0·312308 : 1 : : 18·1173 : 58·01101, or L. 58 0 $2\frac{1}{2}$;

By the Northampton Table,

0·237573 : 1 : : 16·735 : 70·44150, or L. 70 8 $9\frac{3}{4}$;

By the Carlisle Table,

0·408576 : 1 : : 18 889 : 46·23130, or L. 46 4 $7\frac{1}{2}$.

67. Again, to find what funeral allowance an annual contribution of L. 1 from 20 to 70 will afford, we have this proportion: *As the difference between the value of a perpetual annuity of £1 or perpetuity, and the value of an annuity of £1 during life after 20, is to that perpetuity, so is the value of the given annual contribution or temporary annuity to the sum to be received at death.* For, a sum to be received at death, equivalent to an annual contribution during life, may be considered as a perpetuity to be re-

ceived after the termination of a life annuity; and therefore, the value of the given annual contribution or temporary annuity must bear the same relation to the sum to be received at death, as the value of such perpetuity at the commencement of the life annuity, or the reversion of the perpetuity, does to the perpetuity itself.

Thus, in the present case, we have,

By our Table,

$(26^{*} - 18{\cdot}430) = 7{\cdot}570 : 25 :: 18{\cdot}1173 : 59{\cdot}8303,$
or £59 : 16 : $7\frac{1}{4}$ †;

By the Northampton Table,

$(26 - 16{\cdot}973) = 9{\cdot}027 : 25 :: 16{\cdot}735 : 46{\cdot}3471,$
or £46 : 6 : $11\frac{1}{4}$;

By the Carlisle Table,

$(26 - 19{\cdot}298) = 6{\cdot}702 : 25 :: 18{\cdot}889 : 70{\cdot}4603,$
or £70 : 9 : $2\frac{1}{2}$.

68. Lastly, To find the value of an annuity to a widow corresponding to an annual contribution of L. 1 from 20 to 70, when the husband and wife are of the same age, we have only to *subtract the value of an annuity of £1 on two joint lives of the same age, from the value of an annuity on a single life of that age, and the remainder is the value of an annuity of L. 1 to a widow; then raise this annuity in proportion to the value of the given contribution*: Therefore, we have,

---

* The perpetuity here is increased by unity, because the life annuity is so increased. See Note at Art. 41.

† This differs from the result found in Scheme III. by 2s. $6\frac{3}{4}$d. The difference is owing to the manner in which the average number of living throughout the year is taken, by which it happens that the number of the deaths is not always the exact difference between the successive numbers of the living.

By our Tables,

$(18{\cdot}430 - 15{\cdot}363) = 3{\cdot}067 : 1 :: 18{\cdot}1173 : 5{\cdot}907107$,
or L. $5 : 18 : 1\frac{3}{4}$;

By the Northampton Tables,

$(15{\cdot}973 - 12{\cdot}472) \doteq 3{\cdot}501 : 1 :: 16{\cdot}735 : 4{\cdot}7800628$,
or L. $4 : 15 : 7\frac{1}{4}$;

By the Carlisle Tables,

$(18{\cdot}298 - 15{\cdot}538) = 2{\cdot}760 : 1 :: 18{\cdot}889 : 6{\cdot}8438405$,
or L. $6 : 16 : 10\frac{1}{4}$ *.

And, by reducing these values a 21th part, to make a a small allowance for the greater longevity of females,

By our Tables, - -	L. 5	12	$6\frac{1}{2}$;
By the Northampton Tables,	4	11	$1\frac{1}{2}$;
By the Carlisle Tables, -	6	10	4.

* If the annual contributions for Widows' annuity were to continue during life even after 70 years of age, the annuity would be a little more, for we should then have,

By our Tables, -	$3{\cdot}067 : 1 :: 18{\cdot}430 : 6{\cdot}00912$;
By the Northampton Tables,	$3{\cdot}501 : 1 :: 16{\cdot}973 : 4{\cdot}84804$;
By the Carlisle Tables,	$2{\cdot}760 : 1 :: 19{\cdot}298 : 6{\cdot}99202$.

But if the contributions were to continue only so long as both husband and wife were in life, the annuity would be L. 1 less than in the last case, for we should then have,

By our Tables, - -	$3{\cdot}067 : 1 :: 15{\cdot}363 : 5{\cdot}00912$;
By the Northampton Tables,	$3{\cdot}501 : 1 :: 13{\cdot}472 : 3{\cdot}84804$;
By the Carlisle Tables,	$2{\cdot}760 : 1 :: 16{\cdot}538 : 5{\cdot}99202$.

Subjoined is a Table (Table II.) taken from Dr Price, to shew how the contributions are affected by differences between the ages of the husband and wife. This Table is calculated from the Swedish Tables of Mortality, in which the sexes are distinguished, and in which the average rate of mortality does not differ much from that in our Table. The annual contributions are supposed to continue only during the life of both husband and wife.

69. To sum up the whole, it appears,

1*st*, That an annual contribution of L. 1, from the middle of the 21st to the middle of the 71st year, will afford an allowance, for each week of sickness during that period, if we take the sickness as given by the Returns (without interpolation), of,

By our Table, - -	L.	0	19	9½;
By the Northampton Table,		1	1	0¼;
By the Carlisle Table, -		0	19	2¼;

2*dly*, That a similar contribution will afford an annuity for life after 70, of,

By our Table, - -	L.	58	0	2½;
By the Northampton Table,		70	8	9¾;
By the Carlisle Table, -		46	4	7½;

3*dly*, That a similar contribution will afford an allowance at death, of,

By our Table, - -	L.	59	16	7¼;
By the Northampton Table,		46	6	11¼;
By the Carlisle Table, -		70	9	2½;

And, 4*thly*, that a similar contribution will afford an annuity to widows, of,

By our Tables, - -	L.	5	12	6½;
By the Northampton Tables,		4	11	1½;
By the Carlisle Tables, -		6	10	4.

TABLE I.

Shewing the Value of L. 1, when accumulated or discounted, for any Number of Years not exceeding 75, at 4 per cent. Compound Interest.

Years.	Accumulated.	Discounted.
0	£1·000000000000	£1.000000000000
1	1·040000000000	·961538461538
2	1·081600000000	·924556213017
3	1·124864000000	·888996358670
4	1·169858560000	·854804191029
5	1·216652902400	·821927106769
6	1·265319018496	·790314525730
7	1·315931779236	·759917813202
8	1·368569050405	·730690205002
9	1·423311812421	·702586735579
10	1·480244284918	·675564168826
11	1·539454056315	·649580931563
12	1·601032218568	·624597049580
13	1·665073507311	·600574086135
14	1·731676447603	·577475082822
15	1·800943505507	·555264502713
16	1 872981245727	·533908175685
17	1·947900495556	·513373245851
18	2·025816515378	·493628121011
19	2·106849175993	·474642424049
20	2·191123143033	·456386946201
21	2·278768068754	·438833602116
22	2·369918791504	·421955386650
23	2·464715543164	·405726333317
24	2·563304164891	·390121474343
25	2·665836331487	·375116802253
26	2·772469784746	·360689232936
27	2·883368576136	·346816570131
28	2·998703319181	·333477471280
29	3·118651451948	·320651414692
30	3·243397510026	·308318667973
31	3·373133410427	·296460257666
32	3·508058746844	285057940063
33	3·648381096718	·274094173138

TABLE I.—Continued.

Years,	Accumulated,	Discounted,
34	£3·794316340587	£ ·263552089556
35	3·946088994210	·253415470727
36	4·103932553978	·243668721853
37	4·268089856137	·234296847936
38	4·438813450382	·225285430708
39	4·616365988397	·216620606450
40	4·801020627933	·208289044663
41	4·993061453050	·200277927561
42	5·192783911172	·192574930347
43	5·400495267619	·185168202257
44	5·616515078324	·178046348324
45	5·841175681457	·171198411850
46	6·074822708715	·164613857548
47	6·317815617064	·158282555335
48	6.570528241747	·152194764745
49	6·833349371417	·146341119947
50	7·106683346274	·140712615334
51	7·390950680125	·135300591667
52	7·686588707330	·130096722757
53	7·994052255623	·125093002651
54	8·313814345848	·120281733318
55	8·646366919682	·115655512806
56	8·992221596469	·111207223852
57	9·351910460328	·106930022935
58	9·725986878741	·102817329745
59	10·115026353891	·098862817063
60	10·519627408047	·095060401022
61	10·940412504369	·091404231752
62	11·378029004544	·087888684377
63	11·833150164726	·084508350363
64	12·306476171315	·081258029195
65	12·798735218168	·078132720380
66	13·310684626895	·075127615750
67	13·843112011971	·072238092067
68	14·396836492450	·069459703911
69	14·972709952148	·066788176838
70	15·571618350234	·064219400806
71	16·194483084243	·061749423852
72	16·842262407613	·059374446012
73	17·515952903917	·057090813473
74	18·216591020074	·054895012955
75	18·945254660877	·052783666303

TABLE II.

Shewing, both what Single Contribution payable at different ages of a Husband, and also what Annual Contribution, commencing at different ages of a Husband, and continuing during the joint lives of Husband and Wife, will afford an Annuity of £5 for the life of the Wife, after the death of her Husband, when the ages of Husband and Wife are different.

Interest 4 per cent.

Wife's Age.	Husband's Age.	Single Contribution.			Annual Contribution.		
		£	s.	d.	£	s.	d.
16	16	15	6	6	0	19	8½
	22	17	19	2½	1	2	7¼
	28	21	0	9½	1	7	7¼
	34	24	10	4¾	1	13	9½
	40	29	5	4¾	2	3	1¼
	46	34	6	2½	2	14	7¼
	52	40	16	0	3	12	4¾
	58	48	2	7¼	4	18	2½
20	20	15	19	0	1	0	3½
	26	18	12	9½	1	4	7¼
	32	21	16	0	1	10	0
	38	25	15	2½	1	18	0
	44	30	12	1¼	2	8	0
	50	36	10	6	3	3	1¼
	56	43	4	4¾	4	3	7¼
	62	51	1	4¾	5	17	10¾
24	24	16	3	2½	1	1	6
	30	18	19	8½	1	6	2½
	36	22	5	1¼	1	12	2½
	42	26	17	10¾	2	1	9½
	48	31	19	0	2	13	9½
	54	38	5	0	3	12	1¼
	60	45	15	6	5	0	7¼
28	28	16	6	4¾	1	2	9½
	34	19	2	6	1	7	8½
	40	23	3	6	1	15	9½
	46	27	11	7¼	2	5	8½
	52	33	9	4¾	3	1	4¾
	58	40	5	4¾	4	4	6
	64	47	15	7¼	5	19	0
32	32	16	11	7¼	1	4	3½
	38	19	15	2½	1	10	4¾
	44	23	19	1¼	1	19	2½
	50	29	1	3½	2	12	2½
	56	35	2	10¾	3	10	10¾
	62	42	9	6	5	0	6
36	36	16	17	4¾	1	6	1¼
	42	20	18	1¼	1	8	7¼
	48	24	16	4¾	2	3	9½
	54	30	17	0	3	0	4¾
	60	37	4	4¾	4	4	3½
	66	44	7	7¼	6	0	0
42	42	17	6	2½	1	10	0
	48	20	18	1½	1	18	7¼
	54	25	16	3½	2	12	6
	60	32	2	6	3	14	11½
	66	38	16	10¾	5	7	6

Example.—A man of 40 years of age marrying a wife of 16, ought, in order to secure an Annuity of L5 to his Widow, to pay down the sum of L29 : 5 : 4¾, or an annual contribution of L2 : 3 : 1¼ as long as both of them continue in life together; but if the age of the Wife is 28, the single contribution will be only L23 : 3 : 6, and the annual one L1 : 15 : 9½.

APPENDIX

TO

THE REPORT.

No. I.—SCHEDULE of the Particulars after mentioned, taken from the Records of the SOCIETY established at (*a*) in the County of (*a*) by the Name of the (*b*) the (*c*) for giving Aid to the SICK, DISABLED, and SUPERANNUATED Members thereof;—of which Society the Majority of the Members reside in (*d*) and are (*e*) . By the Rules of Admission, Persons in Health from (*f*) to Years of Age are admissible, and after having been Members for (*g*) Years, they are Free, that is to say, they have a right to the Allowance, when Sick, Disabled, or Superannuated. And the Document with which this Schedule is returned Contains a Copy of the Rules and Regulations of the said Society as they exist at present.

YEARLY PERIODS.	THE SOCIETY CONSISTED OF (*i*)											The Total number of weeks' allowances (*m*).	The ALLOWANCES paid to Sick, Disabled, or Superannuated Members were to the extent, in point of time, after mentioned (*m*)																													OBSERVATIONS.
				Of Free Members there were									Of which total number of Weeks Allowances the following number belonged to each of the following Classes, and arose from Bedfast Sickness, Walking Sickness, Superannuation, &c. as stated in the respective Columns.																												
													Under 20.				20 to 30.				30 to 40.				40 to 50.				50 to 60.				60 to 70.				Above 70.				
Year ended (*h*)	Free Members (*k*).	Members not free (*k*).	Total No. of Members.	Under 20 years.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70 years.	The average age of the Free Members at the end of each year was (*l*)		Bedfast Sick.	Walking Sick.	Superannuated.	(*n*)	Bedfast Sick.	Walking Sick.	Superannuated.	(*n*)	Bedfast Sick.	Walking Sick.	Superannuated.	(*n*)	Bedfast Sick.	Walking Sick.	Superannuated.	(*n*)	Bedfast Sick.	Walking Sick.	Superannuated.	(*n*)	Bedfast Sick.	Walking Sick.	Superannuated.	(*n*)	Bedfast Sick.	Walking Sick.	Superannuated.	(*n*)	(*o*)

(*a*) Insert the place where established, and in what county.
(*b*) The name of the Society.
(*c*) The time when it was established.
(*d*) Town or country, as the case may be.
(*e*) Occupation.
(*f*) The ages within which persons are admissible as members, or any other restriction as to admission, if any there be. If under no restriction as to age, &c. mention so.
(*g*) The number of years the persons must have been members to entitle them to claim aid when sick, &c.

Directions for Filling up the Columns.

(*h*) In the first column insert the yearly period, making it that which will give the greatest facility in making up the particulars for the other columns.

For instance,

On line 1st insert 5th July	1820	(*h*)
2d —	1819	
3d —	1818	
4th —	1817	
5th —	1816	

and so on as far back as can conveniently be gone, or any other day, month, and years, as the case may be.

(*i*) In the other columns insert all the particulars indicated by the respective titles belonging to each year, on the line bearing that year; observing, that for new members, and for members who have died or been discontinued in the course of the year, you add the number of months each of these were members in that year together, and, for every twelve of the total thereof, increase the number of members for the whole year *one*, in filling up the schedule: The sick, disabled, and superannuated, as well as the contributing members, are to be included.

(*k*) By free members is meant members who had a right to claim an allowance in case of sickness, disability, or superannuation during the year, if sick, &c. and by members not free, those members who were not so entitled.

(*l*) To find the average age of the free members, add the age of each of them together, and divide the total thereof by the total number of such members.

(*m*) Suppose that, in the course of any year, 8 members had received allowance, viz.

1 for	37	weeks,
1	14	do.
1	29	do.
1	50	do.
1	7	do.
1	12	do.
1	19	do.
1	5	do.

The Total number of which allowances would be......173.

And suppose the three first mentioned had been from 40 to 50 years of age, and *bedfast*, the next one above 70, and superannuated, and the rest from 50 to 60, and walking sick,

In the column Bedfast, under from 40 to 50, ...	80	would fall to be inserted.
In the column Walking sick under from 50 to 60, . . .	43	
In the column Superannuated, above 70, ...	50	
Making up	173	

(*n*) These columns are intended for permanent disability, or any other title to allowances recognised by the Society, and not here mentioned, and are to bear the description applicable thereto; and if the particular distinctions cannot all be made, the total of each class of ages to be inserted in these columns (*n*).

(*o*) If the Society do not give aid to the sick, disabled, or superannuated members during the whole period of sickness, &c. insert in the column of Observations the regulations in that behalf established; and if there were members sick, disabled, or superannuated, and entitled to allowance, who, from their condition in life, or otherwise, did not claim it, insert therein also the number of weeks which, in your estimation, should be added to each class on that account.

When all the particulars required in any case *cannot* be given, give such as can be furnished, which would promote the object of the inquiry, as explained in the advertisement.

Note on the back any other particulars that you judge proper to be given.

No. II.—EXEMPLIFICATION of a Method of collecting and digesting the Materials for the SCHEDULE respecting FRIENDLY SOCIETIES referred to by the HIGHLAND SOCIETY OF SCOTLAND, in an Advertisement dated the 10th July 1820.

The Method is *exemplified* for the period of Twenty Years immediately preceding the 1st January 1821, and formed under a supposition that the Records of the Society do not contain the Age of its respective Members.

Names as they stand in Society's roll for 1801, with the addition of such as have subsequently become Members, inserted in order of entry.	The time of entry of Members *not* free in 1801. Years.	The time when Members, who have ceased to belong to the Society, left it. Years.	The present age of the present Members, or the age of those who have ceased to belong to the Society at the time when they left it.	Age in 1820.	1819.	1818.	1817.	1816.	1815.	1814.	1813.	1812.	1811.	1810.	1809.	1808.	1807.	1806.	1805.	1804.	1803.	1802.	1801.
Robert Thomson,	Free in 1801.	—	57	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38
George Young,	ditto.	—	46	46	45	44	43	42	41	40	39	38	37	36	35	34	33	32	31	30	29	28	27
Thomas Wilson,	ditto.	1817	53	...	...	...	53	52	51	50	49	48	47	46	45	44	43	42	41	40	39	38	37
Robert Johnston,	ditto.	—	59	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44	43	42	41	40
Alexander Hill,	ditto.	—	63	63	62	61	60	59	58	57	56	55	54	53	52	51	50	49	48	47	46	45	44
William Nicol,	1800	1810	48	...	...	...	...	...	...	...	...	...	....	48	47	46	45	44	43	42	41	40	X
George Smith,	1812	—	39	39	38	37	36	35	34	33	X	X											
John Bain,	1812	1816	47	...	...	...	...	47	46	45	X	X											
John Ramsay,	1815	—	35	35	34	33	32	X	X														
Peter Henderson,	1817	—	39	39	38	X	X																
Thomas Watt,	1817	—	26	26	25	X	X																
James Adamson,	1819	—	31	X	X																		
Total number of Free Members,				8	8	6	7	7	7	7	5	5	5	6	6	6	6	6	6	6	6	6	5
of Members not free,				1	1	2	2	1	1	...	2	2	...	...	...	...	...	...	...	...	...	...	1
Total number of Members,				9	9	8	9	8	8	7	7	7	5	6	6	6	6	6	6	6	6	6	6
Free Members of from 20 to 30 years,				1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	1	1	1
30 to 40 years,				3	3	2	2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	2	2
40 to 50 years,				1	1	1	1	2	2	2	1	2	2	4	4	4	4	5	5	5	4	3	2
50 to 60 years,				2	2	2	3	4	4	4	3	2	2	1	1	1	1	...	...	...	...	...	...
60 to 70 years,				1	1	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
above 70 years,				...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
The ages added,				364	356	287	334	343	336	329	246	241	236	279	273	267	261	255	249	243	237	231	186
The average thereof being the result of a division by the number of Free Members,				$45\frac{4}{8}$	$44\frac{4}{8}$	$47\frac{5}{6}$	$47\frac{5}{7}$	49	48	47	$49\frac{1}{5}$	$48\frac{1}{5}$	$47\frac{1}{5}$	$46\frac{3}{6}$	$45\frac{3}{6}$	$44\frac{3}{6}$	$44\frac{3}{6}$	$42\frac{3}{6}$	$42\frac{3}{8}$	$40\frac{3}{6}$	$39\frac{3}{6}$	$38\frac{3}{6}$	$37\frac{1}{5}$

The *Names*, the *Time* of Entry, and the *Time* when persons *ceased* to be Members, are to be found in the Records of all Societies; but these Records, it is understood, in general do not contain the *Age* of each Member: The Roll should therefore be first prepared on one or more sheets of paper, according to the extent of the Society, and the particulars above mentioned, in so far as they can be got from the Records, and are necessary, inserted in the proper columns. A General Meeting should then be called, and, from the information obtained from each of the present Members, his Age at the present time should be inserted in the column prepared for that purpose; and also, from the best information that can be obtained among the Members, the age of each of those persons who have ceased to be Members at the time he left the Society. These form the essential materials from which the other columns of the Account can be filled up and completed at any convenient time.

It falls to be observed, that the mark X denotes a Member *not* Free, and that the example here given goes upon the supposition, that by the Rules of the Society a person must be Two years a Member to entitle him to rank as a Free Member.

It has also to be observed, that in large Societies requiring several sheets of paper, each sheet should be added, and the Totals, being collected on a paper apart, should be brought to a Grand Total, taking care to compute the Average Age on the Grand Total only.

Of the Members named in the above Roll, those following have received support from the Funds of the Society during the periods after mentioned.

	Names.	Weeks Sickness in 1801.	1802.	1803.	1804.	1805.	1806.	1807.	1808.	1809.	1810.	1811.	1812.	1813.	1814.	1815.	1816.	1817.	1818.	1819.	1820.
Note.—The letter W, inserted after the figures, denotes Walking Sick—B, Bedfast—and S Superannuated;—and the small figures below (which should be taken from the prefixed Account, and inserted with red ink) the Age of the person.	George Young,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	15 B / 45	30 S / 46
	Alexander Hill,	...	...	...	...	...	...	...	...	...	...	...	...	12W / 56	...	...	...	17 B / 60	...	...	...
	William Nicol,	...	...	...	...	...	...	...	...	...	19 B / 48	...	...	...	...	...	...	...	...	...	...
	George Smith,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5 B / 36	...	...	...
	Totals,										19			12				22		15	30
	Class from 20 to 30,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
	30 to 40,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	5 B	...	...	...
	40 to 50,	...	...	...	...	...	...	...	...	...	19 B	...	...	...	...	...	...	...	...	15 B	30 S
	50 to 60,	...	...	...	...	...	...	...	...	...	...	...	...	12W	...	...	...	...	...	...	...
	60 to 70,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	17 B	...	...	...
	Above 70,	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

No. III.—RESULTS of RETURNS, by FRIENDLY SOCIETIES of Counties of Ayr, Berwick, Cromarty, Dumfries, East Lothian, Edinburgh, Selkirk, and Stirling, to the Schedule issued by the HIGHLAND SOCIETY

No. of Soc.	NAMES OF SOCIETIES.	Periods which the Returns embrace.	Number of Free Members.							
			Under 20	From 20 to 30.	From 30 to 40.	From 40 to 50	From 50 to 60.	From 60 to 70.	Above 70.	*In all.*
	1st.	From To								
1.	Dunse Friendly Society,	1784–1821		448	1865	2156	1273	512	98	6354
2.	Dunse Benevolent Society,	1805–1821	1	44	598	1085	637	217	35	2617
3.	Deanston Friendly Society,	1798–1821	93	502	648	627	293	98	25	2286
4.	Beith Benevolent Society,	1802–1820	71	464	491	347	286	91		1750
5.	Beith Humane Society,	1800–1820	31	446	538	408	260	65		1748
6.	Beith Brotherly Society,	1800–1820	12	349	568	536	237	40		1733
7.	Canongate Journeymen Cordiners' Society, -	1781–1820	2	269	532	445	250	94	12	1604
8.	Methven Friendly Society,	1795–1821		286	600	435	157	18		1496
9.	Wanlockhead Friendly Society,	1808–1821		1	220	318	399	171	38	1147
10.	Beith Beneficent Society,	1807–1820	37	319	437	240	81			1114
11.	Dunbar Friendly Society,	1812–1820	2	145	186	230	151	117	44	875
12.	Straiton First Friendly Society.	1813–1818	51	140	171	41				403
13.	Forgandenny Friendly Society.	1818–1821	4	85	113	51	16			269
14.	Dalrymple Friendly Society,	1816–1818		56	42	39	36	7	3	183
15.	Rescobie Friendly Society,	1817–1819		46	45	26	18			135
			304	3591	7054	6986	4094	1430	255	23714
	2d.									
16.	Journeymen Goldsmiths' Society, Edinburgh, -	1751–1818		632	1079	546	283	136	71	2747
17.	Glenholm Friendly Society,	1802–1822	4	259	487	522	433	247	50	2002
18.	Journeymen Shoemakers' Society, Hamilton, -	1809–1818		166	421	377	200	65	35	1258
19.	Journeymen Weavers' Society, Hamilton, -	1800–1811		41	190	354	355	146	29	1115
20.	Friendly Weavers' Society, Hamilton, - -	1809–1818		65	317	375	122	34		913
21.	Ramshorn Friendly Society, Hamilton, - -	1809–1818		109	310	261	67			747
22.	The Wrights' Society of Hamilton, - -	1809–1818		41	125	116	30	5	17	334
23.	Society of Haddington Carters.	1809–1819		50	227	193	183	87	20	760
			4	1357	3156	2744	1673	720	222	9876

SCOTLAND, for various periods of years from 1750 to 1821, established in the Forfar, Lanark, Linlithgow, Peebles, Perth, Renfrew, Ross, Roxburgh, of SCOTLAND.

No. of Soc.	Weeks of Sickness of Free Members.								Names of Reporters
	Under 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70.	*In all.*	
1.		240	897	1884	2308	3329	2840	11498	Mr Thomas Dixon, stampmaster, Dunse.
2.		2	344	1263	733	1608	560	4510	Ditto.
3.		2	250½	453	585	310	300½	1901	Mr Dun. Maclaren, Deanston Works, Doune.
4.	42	287	914	436	185	337		2201	Mr Robert Aitken, land-surveyor, Beith.
5.	22	174	335	399	220	294		1444	Ditto.
6.	6	168	223	391	206	157		1151	Ditto.
7.		186	345	444	339	437	236	1937	Mr David Ritchie, Taylor's Land, Cowgate, Edinburgh.
8.		176	206	264	414	577		1637	Mr Richard Wilson, Preses of Society —John Fisher, clerk.
9.			165½	237	1247½	1414	1192	4256	Mr William Watson, surgeon.
10.	26	138	263	178	60			665	Mr Robert Aitken, land-surveyor, Beith.
11.		64	61	65	57	191	616	1054	Mr Thomas Reid, schoolmaster, Dunbar.
12.	11	58	104	4				177	Mr James MacGarragh, Straiton.
13.		87	81	38				206	Rev. Mr Willison, Forgandenny.
14.		52	8	8	106	2		176	Mr William Porteous, schoolmaster, Dalrymple.
15.		84	42	3	10			139	Mr John Arthur, schoolmaster, Rescobie.
	107	1718	4239	6067	5470½	8656	5744½	33002	
16.		200	584	324	170	761	486	2525	Mr Alex. Deuchar, seal-engraver, Edinburgh.
17.		53	105	236	232	248	94	968	Rev. Ham. Paul, Broughton Manse.
18.		31	79	180	700	582	370	1942	Mr Gavin Burns, surveyor, Hamilton.
19.		33	75	615	958	1013	706	3400	Ditto.
20.		29	85	129	265	167		675	Ditto.
21.		•	249	169	25			443	Ditto.
22.			39	330	12	21	602	1004	Ditto.
23.		8	19	46	176	117	719	1085	Mr J. Richardson, writer, Haddington.
		354	1235	2029	2533	2909	2977	12042	

No. III.—RESULTS of

No. of Soc.	Names of Societies.	Periods which the Returns embrace.	Number of Free Members. Under 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70.	In all.
	3d.	From To								
24.	Tranent Carters' Friendly Soc.	1796–1819	144	1270	1285	806	434	170	73	4182
25.	Edinburgh Journeymen Printers' Society, -	1801–1820	3	755	1055	503	275	131	67	2789
26.	Edinburgh Albion Society,	1800–1820		508	1067	497	228	107	3	2410
27.	Hawick New Friendly Society,	1805–1821	4	502	961	663	120			2250
28.	Hawick Old Friendly Society,	1816–1821		251	499	497	386	275	53	1961
29.	New Friendly Journeymen Shoemakers' Society, Edin.	1804–1822	9	820	1678	707	149	4	18	3385
30.	Tain Friendly Society,	1803–1821		364	429	535	404	93		1825
31.	Coldingham Friendly Society,	1814–1822		152	471	416	292	242	50	1623
32.	Journeymen Shoemakers' Second Society of Perth,	1815–1821		279	520	211	288	41		1339
33.	Perth United Mechanics' Friendly Society, -	1812–1821	19	186	441	319	35	17	12	1029
34.	Perth Hammermen Society,	1813–1821		238	316	208	86	12		860
35.	Perth Journ. Masons' Society,	1814–1822		236	293	206	13	7		755
36.	Haddington Benevolent Society	1807–1821		321	458	250	184	57		1270
37.	Niddry Union Society,	1804–1822	54	326	396	283	132	46	3	1240
38.	Leith Journeymen Shipwright Society, -	1797–1821	4	183	399	364	235	62	1	1248
39.	Leith Shipwright Society,	1814–1821		140	174	105	149	38	1	607
40.	Weavers' Society of Water of Leith, - -	1796–1820	2	124	204	241	265	101	90	1117
41.	St John's Lodge of Gardeners, Montrose, -	1816–1821		488	417	126	11			1042
42.	Journeymen Weavers Society, - -	1816–1822	41	460	284	94	9			888
43.	Cromarty Friendly Society,	1815–1821	4	40	207	277	127			655
44.	Incorporation of Sailors, Prestonpans, -	1804–1821		145	165	92	39	67	65	573
45.	Edinburgh Caledonian Gardeners' Society, -	1790–1821		260	1903	1701	610	165	19	4658
46.	Edinburgh Benevolent Society of Royal Archers,	1794–1818		13	89	193	161	105	24	585
47.	Liberal Society of Hamilton,	1809–1818		97	313	199	6			615
			284	8158	14024	9493	4638	1830	479	38906
	4th.									
48.	Strathaven Weavers' Society,	Periods of three years, 1819, 1820, and 1821.		64	77	161	101	21	19	443
49.	Westquarter Friendly Society.		20	106	120	64	54			364
50.	Strathaven Universal Friendly Society, - -			3	117	81	40	28	8	277
51.	Hamilton Liberal Society,			31	86	124	21			262
52.	Straiton First Friendly Soc.		12	103	76	42				233
53.	Hopetoun Lodge of Free Masons, Bathgate,		3	215	231	57	36	10	10	562
54.	Trades' Society of Bathgate,			17	60	33	63	58	29	260
55.	Haddington Caledonian Society,				19	24	31	22	10	106
56.	Benevolent Society of Royal Arch, Edinburgh,			5	15	12	9	9	9	59
			35	544	801	598	355	148	85	2566

RETURNS.—*Continued.*

No. of Soc.	Weeks of Sickness of Free Members. Under 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70.	*In all.*	Names of Reporters.
24.	40	360	826	548	666	681	885	4006	Mr J. Brydon, schoolmaster, Tranent.
25.		365	653	709	251	1358	1027	4363	Mr Alex. Leslie, Caledonian Mercury Office, Edinburgh.
26.		244	944	366	511	793	187	3045	Mr Jas. Hewit, 5. Cowgate, Edin.
27.		364	1119	629	112			2224	Mr Robert Wilson, Hawick.
28.		224	632	760	1118	2118	439	5291	Ditto.
29.	7	404	1783	1200	341	27	482	4244	Mr John Henry, 49. Leith Wynd. Mr A. Cockburn and Mr D. Couper.
30.			426	1028	472	142		2068	Mr Donald Ross, Tain, preses.
31.		485	452	409	766	1512	937	4561	Mr P. Mackay, shoemaker, Coldingham.
32.		520	218	269	1020	135		2162	Mr John Scrimgeour, cabinet-maker, Perth.
33.	15	102	387	259	21	8	106	898	Ditto.
34.		234	149	155	84	8		630	Ditto.
35.		45	74	146		188		453	Ditto.
36.		33	46	202	249	607		1137	Mr Thos. Rutherford, Haddington.
37.	21	97	192	370	298	501		1479	Mr Archibald Weigham, teacher, Nidry Colliery.
38.		200	555	842	316	282	52	2247	Mr John Dawson, shipwright, North Leith.
39.		134	158	113	419	311	52	1187	Ditto.
40.	15	40	123	243	620	898	1867	3806	Mr Robert Paterson, shawl-weaver, Water of Leith.
41.		209	310	115				634	Mr All. F. Macgregor, merchant, Montrose.
42.	18	347	368	79	4			816	Mr Wm. Dick, 33. Cochrane Street, Bathgate.
43.			82	127	83			292	Mr Adam Macrae, Cromarty.
44.		30	61	77	4	113	379	664	Mr Alexander Glen, Prestonpans.
45.		83	909	1331	1353	927	322	4925	Mr Alexander Deuchar, seal-engraver, Edinburgh.
46.		5	27	97	202	174	165	670	Ditto.
47.		213	134	161				508	Mr Gavin Burns, Hamilton.
	116	4738	10628	10235	8910	10783	6900	52310	
48.		72	72	197	263	341	443	1388	Mr Gavin Burns, Hamilton.
49.		99	154	46	15			314	Ditto.
50.			25	23	90	58	69	265	Ditto.
51.		9	34	116	79			238	Ditto.
52.	3	60	37	22				122	Mr James Macgarragh, Straiton.
53.		116	174	23	201	45	312	871	Mr Thomas Dick, writer, Bathgate.
54.			55	47	27	297	1025	1451	Ditto.
55.				7	75	1	266	349	Mr Thos. Rutherford, Haddington.
56.			5	7	21	23	245	301	Mr Alexander Deuchar, seal-engraver, Edinburgh.
	3	356	556	488	771	765	2360	5299	

No. III.—RESULTS of

No. of Soc.	Names of Societies.	Periods which the Returns embrace.	Number of Free Members. Under 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70.	In all.
	5th.									
57.	St John's Lodge, Strathaven,	Periods of three years, 1819, 1820, and 1821.		46	158	216	136	61	14	631
58.	St Andrew's Lodge. Strathaven.			95	266	160	56	14	8	599
59.	Stonehouse Weavers' Society,		26	73	66	69	76	55	22	383
60.	Hamilton Journeymen Shoemakers' Society, -			28	115	96	61	25	19	344
61.	Larkhall Benevolent Society,			46	70	70	62	42	5	295
62.	Friendly Weavers' Society,			10	22	127	72	16		247
63.	Ramshorn Friendly Society, Hamilton, - -			19	84	87	52	3		245
64.	Taylors' Society. Strathaven,			17	53	66	28	14	7	185
65.	Chapleton Friendly Society,			28	68	45	16			155
66.	The Wrights' Society, Hamilton, - -			16	52	39	24	8		139
67.	Journeymen Goldsmiths' Society, Edinburgh, -			67	85	69	18	15	3	257
			20	445	1041	1042	601	253	78	3480
	6th.	From To								
68.	Journeymen Hammermen Society of Edinburgh,	1801–1820	40	808	1021	425	47			2341
69.	Relief Friendly Society, Perth	1814–1821	2	64	131	309	335	41	8	890
70.	Selkirk Friendly Society,	1811–1820	13	1117	1422	793	432	45		3822
71.	The New Bond of Friendship Society in Paisley,	1809–1821	67	871	545	56				1539
72.	Caledonian Society, Paisley,	1805–1821	21	349	429	268	6			1073
73.	Double Friendly Society, do.	1801–1821	107	1846	1760	302	4			4019
74.	Sawyers' Friendly Society, do.	1801–1821	23	214	514	444	192	50		1437
75.	The Journeymen Wrights' Friendly Society, do.	1801–1821	22	625	795	472	91			2005
76.	Paisley Young Friendly Society, - - -	1803–1822	53	1643	1919	401	7			4023
77.	The Montrose Shoemakers, Friendly Society, -	1811–1821		909	671	285				1865
78.	The Stirling Carpet Weavers' Society, - -	1808–1822	6	256	216	177	123	31		809
79.	The Leadhills Friendly Society, Paisley, -	1802–1822	55	712	762	324				1853
			409	9414	10185	4256	1237	167	8	25676
	Summary,	*1st*, 15 Societies,	304	3591	7054	6986	4091	1430	255	23714
		2d, 8 ditto,	4	1357	3156	2744	1673	720	222	9876
		3d, 24 ditto,	284	8158	14024	9493	4638	1830	479	38906
		4th, 9 ditto,	35	544	801	590	355	148	85	2566
		5th, 11 ditto,	20	445	1041	1042	601	253	78	3480
		6th, 12 ditto,	409	9414	10185	4256	1237	167	8	25676
		79 ditto,	1056	23509	36261	25119	12598	4548	1127	104218

RETURNS.—*Continued.*

No. of Soc.	Weeks of Sickness of Free Members. Under 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70.	*In all.*	NAMES OF REPORTERS.
57.		23	59	69	155	197	128	631	Mr Gavin Burns, Hamilton.
58.		51	146	159	97	162		622	Ditto.
59.	22	105	58	22	263	117	95	683	Ditto.
60.		2	71	165	257	459	192	1146	Ditto.
61.			30	108	117	70	112	443	Ditto.
62.			58	204	277	539		1078	Ditto.
63.			68	126	47	4		245	Ditto.
64.		7	32	19	35		28	121	Ditto.
65.		37	28	12	14			91	Ditto.
66.			9	257	11			277	Ditto.
67.		45	127	36	5	310	67	592	Mr Alexander Deuchar, seal-engraver, Edinburgh.
	22	277	692	1180	1278	1858	622	5929	
68.	38	748	700	828	230			2644	Mr James Hewit, 5. Cowgate, Edinburgh.
69.	2	30	75	481	1156	201	39	1972	Mr J. Scrimgeour, cabinet-maker, Perth.
70.		752	1225	761	1533	135		4405	Mr John Paterson, writer, Selkirk.
71.	15	626	382	197				1210	Mr Alexander Boreland, Paisley.
72.	3	86	163	367	60			679	Ditto.
73.	73	1146	1425	696				3550	Ditto.
74.		28	186	436	379	202		1235	Ditto.
75.		512	610	645	206			1971	Ditto.
76.	22	1276	1576	676				3552	Mr Andrew Nairn, clerk, Maxwelton by Paisley.
77.		501	550	329				1380	Mr George Thomson, Montrose.
78.		146	102	199	118	63		628	Mr J. Macfie, carpet-weaver, Stirling.
79.		309	449	306				1064	Mr Alexander Boreland, Paisley.
	153	6464	7544	5807	3724	651	39	24382	
	107	1718	4259	6067	6479½	8656	5744½	33002	
		354	1255	2029	2538	2909	2977	12042	
	116	4738	10628	10235	8910	10783	6900	52310	
	3	356	556	488	771	765	2360	5299	
	22	277	692	1180	1278	1858	622	5929	
	153	6464	7544	5807	3724	651	39	24382	
	401	13907	24894	25806	23691½	25622	18642½	132964	

No. V.—LIST of the NAMES and AGES of the Members of Society, for the Year 1819, and subsequent Years, as kept by the SAILORS' SOCIETY of PRESTONPANS.

NAMES.	Years, and Age each Year.												
	1819.	1820.	1821.	1822.	1823.	1824.	1825.	1826.	1827.	1828.	1829.	1830.	1831.
	Age.	Age.	Age.	Age.	Age.	Age.	Age.	Age.	Age.	Age.	Age.	Age.	Age.
A B, - -	50	51	52	53	Dead.								
C D, - -	45	46	47	48	49								
E F, - -	20	21	22	23	Exclu-ded.								
G H, - -	25	26	27	28	29								
I K, - -	24	25	26	27	28								
L M, - -	*21	*22	*23	24	25								
N O, - -		*26	*27	*28	29								
P Q, - -			*18	*19	*20								

* Denotes that the Member has not yet become *free:* while *unfree* he contributes, but does not receive Allowance.

Nota.—A similar List is kept for the Widows, noting their age annually while in life, and the year in which they die.

No. VI.—FORM OF CASH-BOOK.

* TRANENT CARTERS' FRIENDLY SOCIETY.

RECEIPTS—*Mr W.* BLACK, *Boxmaster.*

		L.	S.	D.	L.	S.	D.
	Brought forward,				62	13	10
1821. Oct. 2.	To Cash from Officer,	5	3	3			
	— G. N. for dinner,	0	1	6			
	— Fines for misconduct on Parade-day,	0	4	0			
					5	8	9
	Carried forward,				68	2	7

TRANENT CARTERS' FRIENDLY SOCIETY.

EXPENDITURE—*Mr W.* BLACK, *Boxmaster.*

	Members' Names.		Age.	Weeks Sick. Bedfast.	Weeks Sick. Walking.	Weeks Sick. Superan	Rate per Week.	Amount paid to each. L.	s.	D.	Total. L.	s.	D.
1821. Oct. 2.	By Thomas Montgomery,		40	12			4s.	2	8	0			
	— Camp. Logan,		55	8			4s.	2	1	0			
	Do. do.			4			3s.						
	— Adam Morrison,		70	8			4s.	1	12	6			
	— George Fowler,		68		5		4s.	1	0	0			
	— John Lumsdean,		69		6		4s.	1	4	0			
	— And. Barber,		78			14	1s 6d.	1	1	0			
	— Alex. Forbes,		78			14	1s 6d.	1	1	0			
	— Peter Brysen,		44			12	1s. 6d.		18	0	11	8	0
	— Geo. Forbes's child's funeral,	£0 15 0											
	— Adam Morrison's funeral,	3 0 0	70								3	15	0
	— Wid. Ogilvie's house-rent,	0 15 0											
	— —— Cairns' do.	0 15 0											
	— —— Notman's do.	0 15 0									2	5	0
	Carried forward,			32	11	40					17	8	0

Form of Order upon the Treasurer.

Tranent, 1st October 1821.

That George Fowler, aged 68, a Member of the Tranent Carters' Friendly Society, is entitled to five Weeks Sick' Money, being unable to work from indisposition, from 26th August to this day, is attested by

H. HUTCHESON, *Member of Committee.*

No. VII.—ANNUAL REPORT OF THE DEANSTON FRIENDLY SOCIETY.

TWENTY-EIGHTH YEAR,

Ending 29th September 1823.

INCOME.

Balance from last year,	£0	1	4			
Twenty-eight Entries,	4	5	6			
Thirty Articles Sold,	0	15	0			
Quarterly Accounts,	46	0	0			
Union Hall Rents,	10	0	0			
Total Income,				£61	1	10

EXPENDITURE.

Bedfast Aliment to 1 Member, 52 Weeks, at 5s.	£13	0	0			
Walking Aliment to 4 Members, in all 116 Weeks, at 2s. 6d.	14	10	0			
Funeral Allowance for 2 Members,	2	0	0			
Annuities to 16 Widows,	16	0	0			
Salaries, to Clerk £1, Officer 15s.	1	15	0			
Cleaning Hall, Fire and Candle, &c.	0	8	2			
Printing Circulars,	0	5	0			
	£47	18	2			
Cash in Treasurer's hands,	13	3	8			
				£61	1	10

STOCK.

One-third Share of Doune Union Hall,	£199	1	0
Copies of Printed Articles,	4	0	2
Cash on hand,	13	3	8
Nett Capital,	£216	4	10
Stock last year,	203	17	6
Gain this year,	£12	7	4

MEMBERS

Admitted, 28—Died, 2 (aged 47 * and 57 †)—Excluded for non-payment of Accounts, 2 (aged 45 and 46, a mechanic and a writer)—Leaving 77 free Members, and 67 not free,—in all 144 effective Members. Average age of free Members 47 years. Average age of all the Members 37½ years.

SICKNESS and SUPERANNUATION among 77 Free Members.

Unfree Memb.	*Free Memb.*		*Weeks Bedfast.*	*Weeks Walking.*
18	...	Members between 12 and 20 years of age,	...	...
32	6	20 and 30,	...	...
13	13	30 and 40,	...	...
4	24	40 and 50,	...	14
...	19	50 and 60,	52	54
...	12	60 and 70,	...	...
...	3	70 and 80,	...	48
67	77	Total 144	52	116

Average sickness to each *free* Member nearly $2\frac{2}{10}$ weeks, being $\frac{2}{10}$ of a week more than last year.

COMMITTEE OF MANAGEMENT for year ending Sept. 1824.

William Campbell, Preses; Thomas Stark, Treasurer; John Crawford, Secretary; John Zuill and John Fisher, Key-Keepers; John Perry, Peter M'Kelvie, James Smith, Alex. Beattie, Dun. M'Laren, John Gentle, James M'Arthur, Hugh Gillespie, Peter M'Gregor, and John Campbell, Ordinary Directors; Duncan M'Dougal and James Bruce, Extraordinary Directors in Glasgow; Daniel M'Nie and David Fulton, Extraordinary Directors in Thornhill; David Rutherford, Officer.

SIR, *Deanston Works, 13th October 1823.*

You are requested to attend a Meeting of the Deanston Friendly Society, to be held in Doune Union Hall, on Monday 29th December next, at 8 o'clock in the Evening, to pay your Quarterly Accounts, amounting to

JOHN CRAWFORD, Sec.

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* The member aged 47 was a weaver, and died at Doune of Hepatitis.

† The member aged 55 was a cotton-spinner, and died at Paisley, of Inflammation of the Chest or Lungs.

No. VIII.

COMPARATIVE STATE

OF THE

AVERAGE ANNUAL SICKNESS

TO AN INDIVIDUAL IN THE

SEVERAL FRIENDLY SOCIETIES,

1st, According to their Classes in point of Age,

2d, In the different Societies viewed each in the Aggregate,

3dly, In the whole Societies in Towns,

4thly, In the whole Societies in the Country.

Difficulties will be found to arise in attempting to compare the sickness of different Societies one with another, whether each Society is viewed as a whole, or considered in its subdivisions into classes or decades. Societies, each viewed as a whole, will seldom stand in circumstances exactly similar as to the numbers and ages of their members; and a comparison according to the average age of the members is liable to fallacy, since two members of 20 and 60 give 40 as the average age, but their united sickness will much exceed that of two members of 40. Even with accurate averages, therefore, comparisons absolutely correct could not be instituted; and further, the average age we are obliged, in the present case, to adopt in making this comparison is not perfectly correct. For the Returns made

by the Societies give the average only of the ages of the members for each year of the Return, and it is an average derived from these which is stated as the general average age of the members of each Society, in comparing their respective sickness.

In comparing Societies in decades, these subdivisions, from the small numbers of each Society, embrace so few members as to debar an approach to uniformity in the rate of sickness; and the diversity in the results represents, in some degree, the varieties of individual cases.

In attempting to ascertain how far health is affected by particular occupations, independent of the considerations already stated, the Returns cannot be considered to afford much aid, since there are very few Societies who limit the admission of members to persons of a particular calling.

When we attempt to ascertain how far health is affected by situation, we find that many cases occur where the Society, though established in a town, has its members chiefly resident in the country: and there are other instances where Societies, though established in the country, have a number of their members resident in towns. Thus the subject is attended with difficulties which preclude accuracy, and an approximation is all that is attainable.

The graduated scale of sickness afforded by the different Societies, when compared in decades, although exhibiting much diversity, gives considerable confidence in the accuracy of the Returns, since the experience of sickness in each Society is borne out, in some measure, by a similar, or nearly similar, experience in some other Society, with very few exceptions originating in accidental causes. A less range of diversity is found in comparing the general sickness of the Societies as bodies; and that range would probably be further lessened, could they be compared un-

der circumstances precisely similar as to numbers and ages. In the classification into *town* and *country*, the last Population Return for Scotland is taken as the rule. Wherever in that return the place of the Societies' establishment is denominated *town*, the sickness is placed under the head *town* in the Comparative State; wherever, in the Population Return, it is denominated *parish*, the sickness is here set down under the title of *country*, with this exception, that the Caledonian Gardeners' Lodge of Edinburgh, in respect of the rural occupation of the members, is placed under the head of *country*.

The occupation of the members is noted, so far as materials are possessed, and it is left blank or marked thus — — —, where these are awanting.

The results of the Census, from 1st May 1820 to 1st May 1821, instituted in the parish of Methven in Perthshire, to ascertain the sickness among the male population, of 15 years of age and upwards, for *one* year, are introduced into this State, for the sake of comparison with the results as derived from the Friendly Society Records, though the latter alone are used as *data* in constructing the Tables. That Census excludes nearly 1 out of 21, on an average of the whole male population of the parish above 15, it being ascertained, that there were 35 persons out of 743, who, from bodily or mental infirmity, could not, at any period of their lives, have been admitted as members of a Friendly Society.

In comparing the Societies in *decades*, the asterisk * denotes that the sickness in the Societies above this mark, exceed, in that decade, the average sickness on which the Tables have been formed, while in the Societies below this mark the sickness is under the average; but the same Society will frequently be found above the average in one decade, and below it in another.

From the small number of members in each Friendly Society, it is unavoidable that considerable variations from the average rate of sickness must occasionally occur, either from excess in the temporary or in the permanent sickness, or in both. So far as observation enables us to judge, it is thought that, when Societies are properly constituted, the chief danger to which they must still remain exposed, will arise from the diversity of degree to which the members of different Societies may become subject to permanent incapacity for labour. Continued incapacity for labour arising to a few persons in a Friendly Society of a small number of members, from accident or from natural failure of constitution, may increase the burden in a particular Society much beyond the average rate.

It is therefore desirable, that Societies should be made fully aware, that while correct calculation may do much in placing their schemes on a more secure footing than hitherto, still that there are contingencies against which calculations made beforehand cannot guard, which can only be obviated by attention on their own part to the progress of the Societies' affairs, and by accommodating their arrangements to their circumstances, on occasion of any peculiar contingency; and the Comparative View may be useful in impressing more strongly this conviction on their members, and exciting that vigilance so essential to the permanence of these institutions. For this reason, although aware that a degree of exactness cannot be attained, the comparison has been instituted.

AVERAGE ANNUAL SICKNESS in different Decades.

No. of Soc. in Results.	OCCUPATIONS.	Average Annual Sickness to an Individual. Town.	Country.
	UNDER 20.		
40.	Weavers and others,		7·500
59.	All trades, -		1·100
69.	Weavers and others,	1·606	
68.	Mechanics, -	·950	
	Census of the parish of Methven, -		·804
33.	Tradesmen, -	·789	
29.	Ditto, -	·777	
5.	Ditto. - -		·709
10.	Ditto. -		·703
73.	— — —	·632	
4.	Tradesmen, -		·592
6.	Ditto, - -		·500
42.	Weavers, -		·439
76.	Various employments,	·415	
37.	Colliers, * * * *		·388
24.	Labourers, -		·277
52.	Mechanics and labourers,		·250
71.	— — —	·224	
12.	Mechanics and labourers,		·216
72.	— — —	·143	

Note.—In a number of Societies no sickness occurs among the members under 20. Vide Results of Returns.

No. of Soc. in Results.	OCCUPATIONS.	Average Annual Sickness to an Individual. Town.	Country.
	FROM 20 TO 30.		
31.	Tradesmen and labourers,		3·191
47.	Mechanics and shopkeepers, -	2·196	
32.	Shoemakers chiefly,	1·864	
15.	Mechanics and labourers.		1·826
59.	All trades, -		1·438
65.	— — —		1·321
48.	Mechanics and labourers,		1·125
38.	Shipwrights, -	1·093	
13.	Farm servants, -		1·023
34.	Tradesmen, -	·983	
39.	Shipwrights, -	·957	
49.	Mechanics and labourers,		·934
14.	Ditto, - -		·928
68.	Mechanics, -	·926	
28.	Ditto and labourers,	·892	
75.	— — —	·819	
	20 to 30—Continued.		
19.	— — —	·895	
73.	— — —	·784	
76.	Various employments,	·778	
42.	Weavers, -		·754
27.	Mechanics, -	·725	
71.	— — —	·719	
60.	Labourers and mechanics,	·714	
	Census of the parish of Methven, -		·693
7.	Shoemakers and others,	·691	
70.	Tradesmen and labourers.	·673	
67.	Goldsmiths, -	·672	
4.	Tradesmen, -		·618
8.	Mechanics mostly,		·615
58.	Freemasons, * * *		·611
52.	Mechanics and labourers,		·583
78.	Carpet weavers,	·570	
77.	Shoemakers, -	·551	
33.	Tradesmen, -	·546	
53.	All occupations,		·539
1.	Mechanics, -		·535
57.	Freemasons, -		·500
6.	Tradesmen, -		·494
29.	Ditto, -	·493	
25.	Printers, - -	·483	
26.	Mechanics, -	·480	
69.	Weavers and others,	·469	
20.	— — —	·446	
11.	All occupations, -	·441	
79.	— — —	·434	
10.	Tradesmen, -		·433
41.	Ditto and labourers,	·428	
12.	Mechanics and labourers.		·414
64.	— — —		·412
5.	Tradesmen, -		·390
46.	All occupations,	·385	
40.	Weavers and others,		·323
45.	Gardeners and others,		·319
16.	Goldsmiths, -	·316	
37.	Colliers, - -		·298
51.	Mechanics and shopkeepers, -	·290	
24.	Labourers, -		·283
72.	— — —	·246	
44.	Sailors, - -		·207
17.	— — —		·205
18.	— — —	·194	
35.	Tradesmen, -	·191	
74.	— — —	·131	

AVERAGE ANNUAL SICKNESS—*Continued.*

No. of Soc. in Results.	Occupations.	Average Annual Sickness to an Individual. Town.	Country.
	20 to 30—Continued.		
23.	— — —	·106	
36.	Tradesmen and labourers,	·103	
2.	Mechanics, -		·045
3.	Cotton-spinners mostly,		·004
	Note.—In some Societies no sickness occurs among the members of this class. Vide Results of Returns.		
	FROM 30 TO 40.		
62.	— — —	2·636	
4.	Tradesmen, -		1·861
67.	Goldsmiths, -	1·494	
38.	Shipwrights, -	1·391	
42.	Weavers, -		1·296
49.	Mechanics and labourers,		1·283
28.	Ditto, -	1·266	
27.	Mechanics, -	1·164	
29.	Tradesmen, -	1·063	
30.	Ditto, -	·993	
31.	Ditto and labourers,		·959
48.	Mechanics and labourers		·935
15.	Ditto, -		·933
54.	Tradesmen, -		·917
39.	Shipwrights, -	·908	
26.	Mechanics, -	·885	
33.	Tradesmen, -	·877	
70.	Ditto and labourers,	·861	
59.	All trades, -		·853
77.	Shoemakers, -	·833	
76.	Various employments,	·821	
73.	— — —	·810	
63.	— — —	·809	
21.	— — —	·803	
68.	Mechanics, -	·774	
75.	— — —	·767	
53.	All occupations,		·753
9.	Miners, - -		·752
41.	Tradesmen and labourers,	·743	
13.	Farm servants, -		·716
71.	— — — * * *	·701	
7.	Shoemakers and others,	·648	
24.	Labourers, -		·643
5.	Tradesmen, -		·623
25.	Printers, -	·619	
60.	Labourers and mechanics,	·617	
12.	Mechanics and labourers		·608

No. of Soc. in Results.	Occupations.	Average Annual Sickness to an Individual. Town.	Country.
	30 to 40—Continued.		
64.	— — —		·604
40.	Weavers and others,		·603
10.	Tradesmen, -		·602
79.	— — —	·589	
2.	Mechanics, -		·575
69.	Weavers and others,	·573	
58.	Freemasons, -		·549
16.	Goldsmiths, -	·541	
61.	Labourers and mechanics,		·514
52.	Ditto, -		·487
37.	Colliers, - -		·485
1.	Mechanics, -		·481
45.	Gardeners and others,		·478
34.	Tradesmen, -	·472	
78.	Carpet weavers,	·472	
	Census of the parish of Methven, -		·446
47.	Mechanics and shopkeepers, -	·428	
32.	Shoemakers mostly,	·419	
65.	— — —		·412
43.	Tradesmen, -	·396	
51.	Mechanics and shopkeepers, -	·395	
19.	— — —	·395	
6.	Tradesmen, -		·393
3.	Cotton-spinners & others,		·386
72.	— — —	·380	
57.	Freemasons, -		·373
44.	Sailors, - -		·370
74.	— — —	·366	
8.	Mechanics mostly,		·343
56.	All occupations,	·333	
11.	Ditto, - -	·328	
22.	— — —	·312	
46.	All occupations,	·303	
20.	— — —	·268	
35.	Tradesmen, -	·253	
17.	— — —		·216
50.	Mechanics and labourers,		·214
14.	Mechanics and labourers,		·190
18.	— — —	·188	
66.	— — —	·173	
36.	Tradesmen and labourers,	·100	
23.	— — —	·084	
	Note.—The Haddington Caledonian Society reports 19 members of these ages, but none sick.		

AVERAGE ANNUAL SICKNESS—*Continued.*

No. of Soc. in Results.	Occupations.	Average Annual Sickness to an Individual. Town.	Country.
	From 40 to 50.		
66.	— — —	6·590	
71.	— — —	3·339	
22.	— — —	2·845	
	Census of the parish of Methven,		2·658
38.	Shipwrights,	2·313	
73.	— — —	2·007	
68.	Mechanics,	1·951	
30.	Tradesmen,	1·921	
19.	— — —	1·737	
60.	Labourers and mechanics,	1·719	
29.	Tradesmen,	1·697	
76.	Various employments,	1·688	
62.	— — —	1·606	
61.	Labourers and mechanics,		1·543
28.	Ditto.	1·529	
69.	Weavers and other occupations,	1·518	
63.	— — —	1·448	
54.	Tradesmen,		1·424
25.	Printers,	1·409	
72.	— — —	1·369	
75.	— — —	1·362	
37.	Colliers,		1·307
32.	Shoemakers mostly,	1·275	
4.	Tradesmen,		1·256
48.	Mechanics and labourers,		1·224
2.	Mechanics,		1·164
77.	Shoemakers,	1·144	
78.	Carpet-weavers,	1·124	
39.	Shipwrights,	1·076	
40.	Weavers and others, * *		1·008
7.	Shoemakers and others,	·998	
58.	Freemasons,		·994
74.	— — —	·986	
5.	Tradesmen,		·978
70.	Tradesmen and labourers,	·959	
31.	Ditto,		·959
27.	Mechanics,	·949	
79.	— — —	·944	
51.	Mechanics and shopkeepers,	·935	
41.	Tradesmen and labourers,	·913	
1.	Mechanics,		·873
42.	Weavers,		·840
44.	Sailors,		·837
33.	Tradesmen,	·812	
47.	Mechanics and shopkeepers,	·809	
36.	Tradesmen and labourers,	·808	
45.	Gardeners and others,		·782
	40 to 50—*Continued.*		
9.	Miners,		·745
13.	Farm servants,		·745
34.	Tradesmen,	·745	
10.	Ditto,		·742
26.	Mechanics,	·736	
6.	Tradesmen,		·729
3.	Cotton-spinners mostly,		·722
49.	Mechanics and labourers,		·719
35.	Tradesmen,	·709	
24.	Labourers,		·680
21.	— — —	·647	
8.	Mechanics mostly,		·607
16.	Goldsmiths,	·593	
56.	All trades,	·583	
67.	Goldsmiths,	·551	
52.	Mechanics and labourers,		·524
46.	All occupations,	·503	
18.	— — —	·477	
43.	Tradesmen,	·458	
17.	— — —		·454
53.	All occupations,		·404
20.	— — —	·344	
59.	All trades,		·333
57.	Freemasons,		·319
55.	Mechanics and labourers,	·292	
64.	— — —		·288
50.	Mechanics and labourers,		·284
11.	All occupations,	·283	
65.	— — —		·279
23.	— — —	·238	
14.	Mechanics and labourers,		·205
15.	Ditto,		·115
12.	Ditto,		·097
	From 50 to 60.		
72.	— — —	10·000	
53.	All occupations,		5·583
68.	Mechanics,	5·085	
60.	Labourers and mechanics,	4·213	
62.	— — —	3·847	
51.	Mechanics and shopkeepers,	3·762	
70.	Tradesmen and labourers,	3·625	
32.	Shoemakers mostly,	3·541	
18.	— — —	3·500	
59.	All trades,		3·460
69.	Weavers and other occupations,	3·451	

AVERAGE ANNUAL SICKNESS—*Continued.*

No. of Soc. in Results.	OCCUPATIONS.	Average Annual Sickness to an Individual. *Town.*	*Country.*
	50 to 60—*Continued.*		
9.	Miners, -		3·126
14.	Mechanics and labourers,		2·944
28.	Ditto, -	2·896	
39.	Shipwrights, -	2·812	
19.	— — —	2·698	
8.	Mechanics mostly,		2·637
31.	Tradesmen and labourers,		2·623
48.	Mechanics and labourers,		2·604
	Census of the parish of Methven, -		2·597
55.	Mechanics and labourers,	2·419	
40.	Weavers and others,		2·340
56.	All trades,	2·333	
29.	Tradesmen,	2·288	
75.	— — —	2·264	
37.	Colliers,		2·258
50.	Mechanics and labourers,		2·250
26.	Mechanics,	2·241	
45.	Gardeners and others,		2·218
20.	— — —	2·172	
3.	Cotton spinners mostly,		1·996
74.	— — —	1·974	
61.	Labourers and mechanics,		1·887
1.	Mechanics,		1·813
58.	Freemasons,* * * *		1·732
24.	Labourers,		1·534
7.	Shoemakers and others,	1·356	
36.	Tradesmen and labourers,	1·353	
38.	Shipwrights,	1·345	
46.	All occupations,	1·255	
64.	— — —		1·250
30.	Tradesmen,	1·168	
2.	Mechanics,		1·151
57.	Freemasons,		1·140
34.	Tradesmen,	·977	
23.	— — —	·962	
78.	Carpet weavers,	·959	
27.	Mechanics,	·933	
25.	Printers, -	·912	
63.	— — —	·904	
65.	— — —		·875
6.	Tradesmen, -		·869
5.	Ditto. -		·846
10.	Ditto. -		·741
43.	Ditto. -	·654	
4.	Ditto. -		·647
16.	Goldsmiths, -	·601	
33.	Tradesmen, -	·600	
15.	Mechanics and labourers,		·555
17.	— — —		·536

No. of Soc. in Results.	OCCUPATIONS.	Average Annual Sickness to an Individual. *Town.*	*Country.*
	50 to 60—*Continued.*		
66.	— — —	·458	
42.	Weavers, -		·444
54.	Tradesmen, -		·429
22.	— — —	·400	
11.	All occupations,	·377	
21.	— — —	·373	
49.	Mechanics and labourers,		·278
67.	Goldsmiths, -	·278	
44.	Sailors, - -		·103
	Note.—Some Returns exhibit no sickness in this decade. Vide Results of Returns.		
	FROM 60 TO 70.		
62.	— — —	33·687	
8.	Mechanics mostly,		32·055
35.	Tradesmen, -	26·857	
67.	Goldsmiths, -	20·666	
60.	Labourers and mechanics,	18·360	
48.	Ditto, -		16·238
58.	Freemasons, -		11·571
37.	Colliers, -		10·891
36.	Tradesmen and labourers,	10·650	
25.	Printers,	10·366	
18.	— — —	8·954	
9.	Miners,		8·269
39.	Shipwrights,	8·184	
28.	Mechanics and labourers,	7·702	
26.	Ditto, -	7·411	
2.	Mechanics,		7·410
19.	— — —	6·938	
29.	Tradesmen,	6·750	
1.	Mechanics,		6·502
31.	Tradesmen and labourers,		6·248
45.	Gardeners and others,* *		5·618
16.	Goldsmiths,	5·595	
	Census of the parish of Methven,		5·454
54.	Tradesmen,		5·121
20.	— — —	4·912	
69.	Weavers and other occupations,	4·902	
40.	Weavers and others,		4·702
7.	Shoemakers and others,	4·649	
38.	Shipwrights,	4·548	

AVERAGE ANNUAL SICKNESS—*Continued.*

No. of Soc. in Results.	Occupations.	Average Annual Sickness to an Individual. Town.	Country.
	60 to 70—Continued.		
5.	Tradesmen,		4·523
53.	All occupations,		4·500
22.	— — —	4·200	
70.	Tradesmen and labourers,	4·111	
74.	— — —	4·040	
24.	Labourers,		4·006
6.	Tradesmen,		3·925
4.	Ditto,		3·703
32.	Shoemakers mostly,	3·292	
57.	Freemasons,		3·229
3.	Cotton spinners mostly,		3·163
56.	All trades,	2·555	
59.	Ditto,		2·127
50.	Mechanics and labourers,		2·071
78.	Carpet weavers,	2·032	
44.	Sailors,		1·687
61.	Labourers and mechanics,		1·666
43.	All occupations,	1·657	
11.	Ditto,	1·632	
30.	Tradesmen,	1·527	
23.	— — —	1·345	
63.	— — —	1·333	
17.	— — —		1·004
34.	Tradesmen,	·666	
33.	Ditto,	·471	
14.	Mechanics and labourers,		·286
55.	Ditto,	·045	
	Note.—Several Returns exhibit no members of this age. Vide Results of Returns.		
	ABOVE 70.		
26.	Mechanics,	62·333	
39.	Shipwrights,	52·000	
38.	Ditto,	52·000	
23.	— — —	35·950	
22.	— — —	35·412	
	Above 70—Continued.		
54.	Tradesmen,		35·345
9.	Miners,		31·368
53.	All occupations,		31·200
1.	Mechanics,		28·979
56.	All trades,	27·222	
29.	Tradesmen,	26·777	
55.	Mechanics and labourers,	26·000	
	Census of the parish of Methven,		24·745
19.	— — —	24·345	
48.	Mechanics and labourers,		23·316
61.	Ditto,		22·400
67.	Goldsmiths,	22·333	
40.	Weavers and others,		20·744
7.	Shoemakers and others,	19·666	
31.	Tradesmen and labourers,		18·740
45.	Gardeners and others,		16·947
2.	Mechanics,		16·000
25.	Printers,	15·328	
11.	All occupations,	14·000	
24.	Labourers,		12·123
3.	Cotton-spinners mostly,		12·020
18.	— — —	10·571	
60.	Labourers and mechanics,	10·105	
57.	Freemasons,		9·143
33.	Tradesmen,	8·833	
50.	Mechanics and labourers.		8·625
28.	Ditto,	8·283	
46.	All occupations,	6·875	
16.	Goldsmiths,	6·845	
44.	Sailors,		5·831
69.	Weavers and other occupations,	4·875	
59.	All trades,		4·318
64.	— — —		4·000
17.	— — —		1·880
	Note.—Many Returns exhibit no members of this age. Vide Results of Returns.		

Note.—A member dying before the middle of the year, is held as dying in the year preceding, and the sickness of the year in which he died is added to that of the preceding year.

GENERAL AVERAGE ANNUAL SICKNESS to an INDIVIDUAL in the SOCIETIES according to the Returns.

No. of Soc. in Results.	OCCUPATIONS.	Average Age.	Average Annual Sickness to an Individual. Town.	Country.
	I. *Where none of the ages exceed* 50.			
71.	— — —	29·5	·7862	
77.	Shoemakers,	29·6	·7432	
12.	Mechanics and labourers,	29.7		·4392
76.	Various employments, -	29·9	·8830	
73.	— — —	30·0	·8838	
52.	Mechanics and labourers,	30·6		·5236
41.	Tradesmen and labourers,	32 0	·6084	
79.	— — —	32·9	·5743	
13.	Farm servants,	34·5		·7657
47.	Mechanics and shopkeepers,	36·5	·8260	
	II. *Where none of the ages exceed* 60.			
42.	Weavers, -	33·0		·9189
68.	Mechanics, -	31·4	1·1294	
72.	— — —	32·6	·6328	
10.	Tradesmen, -	34·4		·5969
65.	— — —	35·4		·5871
15.	Mechanics and labourers,	35·5		1·0296
27.	Mechanics, -	35·7	·9684	
49.	Mechanics and labourers, -	35·8		·8828
75.	— — —	36·1	·9830	
43.	Tradesmen,	36·5	·4458	
21.	— — —	38·8	·5930	
51.	Mechanics and shopkeepers,	46·2	·9084	
66.	— — —	41·3	1·9928	
64.	— — —	44·5		·6540
	III. *Where none of the ages exceed* 70.			
78.	Carpet-weavers,	35·5	·7763	
35.	Tradesmen,	35·7	·6000	
70.	Tradesmen and labourers,	36·0	1·1745	
34.	Tradesmen,	36·5	·7325	
37.	Colliers, -	36·5		1·1927
8.	Mechanics mostly,	36·7		1·0942
5.	Tradesmen, -	37·8		·8260
4.	Ditto, -	38·0		1·2577
6.	Ditto, -	38·7		·6642
58.	Freemasons,	38·9		1·0038

No. of Soc. in Results.	OCCUPATIONS.	Average Age.	Average Annual Sickness to an Individual. Town.	Country.
36.	Mechanics and labourers,	39·1	·8953	
14.	Ditto, -	39·5		·9617
32.	Shoemakers mostly,	39·5	1·6146	
74.	— — —	39·9	·8594	
20.	— — —	42·1	·7393	
63.	— — —	42·2	1·0000	
30.	Tradesmen, -	44·3	1·1331	
62.	— — —	47·3	4·3643	
	IV. *Where some of the ages exceed* 70.			
29.	Tradesmen, -	34·5	1·2538	
24.	Labourers, -	36·2		·9579
53.	All occupations,	36·6		1·5498
33.	Tradesmen, -	38·4	·8727	
25.	Printers, -	38·4	1·5643	
67.	Goldsmiths, -	38·5	2·3035	
3.	Cotton-spinners mostly,	38·8		·8315
26.	Mechanics,	38·8	1·2634	
16.	Goldsmiths, -	40·0	·9192	
7.	Shoemakers & others,	40·7	1·2387	
39.	Shipwrights,	41·0	1·9555	
38.	Ditto, -	41·1	1·8004	
22.	— — —	41·3	3·0060	
45.	Gardeners & others,	41·8		1·0573
18.	— — —	42·0	1·5437	
44.	Sailors, -	43·0		1·1588
1.	Mechanics, -	43·0		1·8095
17.	— — —	43·9		·4835
59.	All trades, -	44·4		1·7833
64.	— — —	44·5		·6540
50.	Mechanics and labourers,	44·8		·9567
43.	Ditto, -	44·8		3·1332
60.	Ditto, -	44·9	3·3313	
61.	Ditto, -	44·9		1·5017
28.	Ditto, -	45·0	2·6981	
31.	Ditto, -	45·5		2·8102
11.	All occupations,	45·6	1·2045	
57.	Freemasons,	45·6		1·0000
23.	— — —	45·8	1·4276	
2.	Mechanics, -	46·5		1·7233
69.	Weavers and other occupations,	47·0	2·2157	
4[illegible].	Weavers and others,	49·1		3·4073
9.	Miners, -	49·3		3·7105
19.	— — —	50·0	3·0493	
56.	All trades, -	50·4	5·1016	
46.	All occupations,	50·6	1·1453	
54.	Tradesmen, -	51·0		5·5807
55.	Mechanics and labourers,	52·0	3·[illegible]	

AVERAGE SICKNESS IN TOWNS.

The Members of Friendly Societies in Towns—as to Numbers—Total Sickness—and the Average Annual Sickness to an Individual—stand as follows.

	Under 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70.
Numbers, -	456	16523	23366	13591	6023	1898	456
Total Sickness,	175	10367	17149	16207	12397	11427	7054
Average Annual Sickness to an Individual,	·3837	·6274	·7339	1·1924	2·0582	6.0205	15·4692

AVERAGE SICKNESS IN THE COUNTRY.

The Members of Friendly Societies in the Country—as to Numbers—Total Sickness—and the Average Annual Sickness to an Individual—stand as follows.

	Under 20.	From 20 to 30.	From 30 to 40.	From 40 to 50.	From 50 to 60.	From 60 to 70.	Above 70.
Numbers, -	600	6986	12895	11528	6575	2650	671
Total Sickness,	226	3540	7745	9599	11294½	14195	11588½
Average Annual Sickness to an Individual.	·3766	·5067	·6006	·8326	1·7177	5·3566	17·2704

ON

WEDGE-DRAINING CLAY LAND

IN A

LETTER FROM CHARLES ALEXANDER MOIR, ESQ. OF LECKIE, TO H. HOME DRUMMOND, ESQ. OF BLAIR-DRUMMOND, M. P.

LETTER from H. Home Drummond, Esq. addressed to the Secretary to the Highland Society.

SIR, *Blair-Drummond, Dec.* 24. 1823.

In compliance with the request, expressed at a meeting of the Committee of the Highland Society, that I should furnish a statement of the mode of Wedge-Draining Carse Land, now practised in this part of the country, I applied to my friend, Mr Moir of Leckie, as being much better qualified than I am to supply the information required; and I have the satisfaction to transmit to you the inclosed communication, containing the result of his experience on the subject, with his permission to place it at the disposal of the Directors. As this information appears to me most important

to all persons interested in the cultivation of the valuable description of soil to which it relates, I hope such measures may be adopted as are best calculated to make it generally known. In this particular district, Wedge-Draining is so rapidly extending, as hardly to require encouragement. On this estate alone, the tenants have, within these three or four years, drained above 200 acres, at their own expence. But I believe there are other districts well calculated for this species of improvement, where it has not yet been introduced.

As Mr MOIR's statement is not accompanied with a sketch of the tools, I beg leave to subjoin one of the tools at present used with great success in draining a field here. These vary in some particulars from the dimensions of those used by Mr MOIR, but I believe the difference is of no material consequence. The turf-spade (Pl. VII. Fig. 3.) is found to be very useful, where the ground to be drained has been so long in pasture, that the turf cut from the surface of the drain serves for covering it.—I remain, Sir, your most obedient humble servant,

H. HOME DRUMMOND.

March 31. 1824.

P. S.—Since Mr MOIR's Statement was written, I understand from Mr MURRAY of Polmaise, that bricks have been used by him with the greatest success in covering wedge-drains; and, where there is a scarcity of proper turf, it is very likely that this may be found to be the best and cheapest mode.

The bricks so used are narrower on the lower than on the upper side, and fit the wedge-drains like the key-stone of an arch *.

Some experiments in draining have been lately made with a plough, constructed for that purpose, by Robert Robertson, an ingenious blacksmith at Drip Bridge, near Stirling, and which, it is hoped, may lead to a great saving of labour; but, as it is intended to make some alterations on the machine, and to submit its application to the test of farther experiments, it would be premature, and perhaps injurious, to give a particular account of it at present.

H. H. D.

No. I.—Turf Spade.
Plate VII. Fig. 3.

	Inches.
Breadth of Plate at top,	$5\frac{1}{2}$
Do. of do. at bottom,	5
Length of do. -	11
Do. of shaft, - - -	$30\frac{1}{2}$

No. II.
Plate VII. Fig. 4.

Breadth of Plate at top,	6
Do. of do. at bottom,	4
Length of do. - -	17
Do. of Shaft, - -	27

No. III.
Plate VII. Fig. 5.

	Inches.
Breadth of Plate at top,	5
Do. of do. at bottom,	2
Length of do. -	$17\frac{1}{2}$
Do. of shaft, - - -	$28\frac{1}{2}$

No. IV.
Plate VII. Fig. 6.

Diam. of Scoop, -	2
Length of do. - -	14
Do. of Shaft, - -	5 ft. 9

The Scoop is at an angle of 45 deg. to the Shaft.

* A Bill is now (June 1824) in progress through Parliament, in which a clause is introduced, it is believed on Mr Drummond's suggestion, for exempting from duty, under certain regulations, all bricks and tiles used in drainage.

LETTER from Charles Alex. Moir, *Esq. of Leckie, to* H. Home Drummond, *Esq. M. P.*

My dear Sir,

I have much pleasure in complying with your request, that I would communicate to you, for the information of the Highland Society, the result of my experience in Wedge-Draining; and it will give me very sincere satisfaction, if I can be in any degree instrumental in rendering more general a practice which I consider as the most important improvement that has been introduced into the management of carse lands since I knew any thing about farming.

You are aware, that your own tenant John Blair, with a sagacity and spirit of enterprise infinitely creditable to him, when his limited means are taken into consideration, about the year 1816, took, from an article in the Farmers' Magazine, pointed out to him by Mr Robert Forrester of Polder, at that time his landlord, the idea of draining the land he cleared from the moss, on a principle nearly similar to wedge-draining, though more expensive in the execution, and, I believe, less likely to prove durable. He assures me, however, that the first drains he made are still running very well. For want of the proper spade, he could not cut his drains in the way now generally practised; but his method was to cut a trench in the clay, more or less deep accord-

ing to circumstances, and of a proportionable width, in the bottom of which he cut his drain, with a narrow and sharp pointed spade. He then covered this narrow drain with a firm turf, taken from the surface of the moss, and afterwards filled up the trench with the clay that had been taken out of it. This will be better understood, perhaps, by looking at the transverse section of his drain, in Pl. VII. Fig. 1. where the dotted part represents the turf.

This method, which was originally, I believe, invented in Essex, and has been long practised in that county, and in other parts of England, Blair found to succeed so well, that it was with great difficulty I prevailed upon him to try the plan he saw my people following; but, notwithstanding his natural partiality to his old system, a short trial convinced him of the superior advantages of the new method.

Our friend Mr Murray of Polmaise having seen wedge draining practised extensively in Wigtonshire, was instantly sensible of its utility, and it is to him entirely that we owe the introduction of it into Stirlingshire, from whence it has spread to Clackmananshire, and part of Perthshire. He brought to Polmaise a number of Irish labourers, who had been trained to that sort of work in Galloway, and set the example, by draining a large field, as far back, I think, as 1815. Since that time, he has drained a great deal more, and continues to do so with perfect success. His example was soon followed by Lord Abercromby, Mr Graham

Stirling of Airth, and several others of his friends, who saw his operations, and it is now become very general in this neighbourhood. I was later of beginning than several of my neighbours, partly owing to the difficulty of procuring hands accustomed to it, but chiefly owing to my having been at that time fully occupied in bringing up some expensive leading drains from the Forth, which were necessary as a preliminary step to that or any other material improvement; but I believe nobody in this part of Scotland has carried the practice to such an extent as I have now done. I cannot say exactly how much land I have wedge-drained, but I am pretty sure it exceeds 150 acres.

The first field I drained in this way, (six years ago), was not much improved by the operation. Indeed, with respect to the greater part of the field, I reckoned it a complete failure, owing to the soil having been too sandy; though undoubtedly the first crop or two were much better than they would have been had the field not been drained. In my second trial I was much more successful. It was a field of 12 acres then, (in the summer of 1818), under summer fallow. After being drained, it was sown with wheat, along with grass-seeds, and produced a very heavy crop, much too heavy indeed for the grass, although it only got rather a slight dunging, and no lime. It has been in pasture under sheep ever since, and continues in a great measure free from rushes and coarse aquatic grasses, with which it used to be much overrun before it was drained. Yet

some of the drains have given way near their mouths, partly, perhaps, from having been cut into by moles and water-mice, but partly also, I suspect, from their having too great a fall near their termination in a ditch. The water owing to this cause, running too rapidly, has, I think, wasted the bottom, and undermined the sides of these drains, so as to cause the turf to fall down and choke them. To remedy this, I some time ago had a transverse drain cut across the ridges. from one side of the field to the other, so as to carry off the water from any of the drains that were stopped, and that seems to have answered the purpose very well.

Most of the other lands that I have drained have been in the occupation of tenants, and wherever sufficient attention has been paid to keep the ditches clear, so as not to choke up the mouths of the drains, (a point of great consequence), they appear to have succeeded very well, and I feel confident, that, wherever the soil is fitted for the purpose, the work properly executed, the drains of a sufficient depth, and where there is no improper treatment or neglect on the part of the farmer, these drains will answer the most sanguine expectations. I think they should never be less than three feet deep, otherwise they are apt to give way, either from moles getting down into them in very dry weather, or from the feet of the horses employed in ploughing, when the ground is wet, sinking so far as to injure the turf.

The wedge-drains have no shoulders, like those originally made by John Blair; but the sides have a regular slope from top to bottom, as may be seen in the transverse section, (Plate VII. Fig. 2.), where, as in Fig. 1. the dotted part represents the turf.

The work is performed by means of three spades of different sizes. The first, Fig. 3. may be a common spade of moderate breadth, with which the surface-clay may be taken off to the depth of 8 or 10 inches, or not quite so much, if the clay be very strong. The breadth of the drain, at top, may be from a foot to 15 inches; but it never should be less than a foot, as it is an advantage that the sides should have a considerable slope,—and the two sides should slope as equally as possible. Another workman follows the first, with a spade six inches broad at the top, and becoming narrower towards the point, where it should not exceed four inches, (Plate VII. Fig. 4.) The length of the plate of this second spade should be 14 inches, and with it a foot or 14 inches in depth can easily be gained. A third workman, and he should be the most expert, succeeds the second, and his spade should be four inches broad at top, only two inches broad at the point, and 14 or 15 inches in length, (Plate VII. Fig. 5.) With this spade a good workman can take out at least 15 inches of clay. A sort of hoe or scoop, made of a plate of iron formed nearly into the shape of an half cylinder, of two inches diameter, and a foot or 14 inches long, and fastened at an acute angle of perhaps 70°, to a long wooden handle, (Plate VII.

Fig. 6.) is now employed to scrape out the bottom of the drain, and remove any small pieces of clay that may have fallen into it.

This completes the cutting of what is by the workmen called a three *stamp* drain. Where circumstances may render it necessary, they may be made of four, five, or more *stamps*. A tenant of mine made a drain in this way six feet deep, to bring water into a pump-well in his farm-yard, which answers perfectly. Mr Murray has also made some drains six feet deep, while others have made them of a depth not much exceeding two feet; but, I repeat, that I would in no case, unless, perhaps, where the land is to remain permanently in sheep-pasture, and is free from moles, recommend their being made less than three feet deep, and I am inclined to think, that where the levels will admit of it, it would almost always be more advantageous that the depth should be four feet. Where the field is in summer fallow at the time, six inches of depth can generally be gained by gathering the ridges pretty high, and taking as deep a water-furrow as possible, with a wide-set plough. Three *stamps* or spits taken from the bottom of this water-furrow will give a depth of at least three feet and a half, when the ridges are reduced to the proper shape, which is easily done in the course of the subsequent ploughings. In all cases I think it best to put a drain in every furrow, though some people put only one in every second furrow.

The drain being cut of the dimensions required, the next step is to fill it properly. At first, when this mode of draining was introduced into Stirlingshire, we always used a wedge of turf for this purpose, and, where it could be got, we generally preferred the tough green turf, which is in many places to be found on the surface of peat-moss, and I still believe there is nothing preferable to it. Where that is not to be got, turfs from the surface of wet clay land, much matted with the roots of coarse grasses, answer remarkably well; and, since these have become scarce, we have found any good firm turfs quite sufficient, and we very often take them from the field we are draining, if it has been a few years in pasture. The turfs should be cut into an oblong shape, about four inches and an half broad, (some make them narrower a little at the grassy side than at the other, but this is not very easily done, and, I believe, not very material), and from three to five inches thick. They are generally made about fourteen inches long. The grassy side of the turf being turned undermost, they are put down into the drain, the workman standing upon them after they are put in, and pressing them down with his whole weight, till they are firmly wedged between the sloping sides of the drain. The ends of the turfs being cut somewhat obliquely, they overlap each other a little, and by this means, although there is sufficient opening for the surface-water to get down, nothing else can. The open space, below the turf, ought to be about five or six

inches in depth, three inches wide at top, and one and an half, or two inches, at bottom. Some people prefer making the turf a little broader, and, by that means, leaving a larger space below, from the idea that it will be less likely to choke up, but these are the dimensions I have found to answer best, and Mr Murray's experience on this subject coincides with mine. When the open space is much larger, the sides of the drain, below the turf, are probably more apt to give way for want of support.

The operation may now be completed, by turning in as much earth, either with the spade or the plough, as to fill up the drain to the proper level. I commonly find it very advantageous to fill up the drain with the loose surface earth, and to give a sort of top-dressing to the ridge with the fresh clay from the bottom of the drain. By this means the surface-water gets more easily down, and the fresh soil will in general, be found to improve the field very materially.

The difficulty of procuring proper turf in many situations, has led, of late, to some trials of various substitutes for it, such as clay, peat, wood, and even stone. A person of the name of Ballingall, who came to this neighbourhood about two years ago, has been employed as a wedge-drainer by several gentlemen. He uses clay instead of turf, in a way that, he says, he has seen successfully practised for more than thirty years in Holland. I have no means of confirming the accuracy of this statement; but the experiments that have been made in that

way in this country do not yet warrant my recommending it. In some instances it has certainly failed, perhaps from the clay not being sufficiently strong, or, as Mr Murray, who has given it a trial, plausibly enough supposes, from its being employed in too dry a state. This man's method is the following.

After the drain is cut, he introduces into it a frame of wood about four feet long, and, in its other dimensions, corresponding to the size of the open space he wishes to leave in the bottom of the drain. Tough wet clay is then thrown in upon this, and firmly beaten down, nearly in the way in which it would be done in puddling the bottom of a piece of water. The frame of wood is then drawn forward in the drain, by means of a ring in one end of it, and the same process is repeated till the drain is completed. I have myself no experience of this method, nor should I like to try it on an extensive scale, till the durability of the drains thus formed is better ascertained. Perhaps one reason of the failure may be, that the puddle being almost impermeable to the water, it can only escape laterally, and, from lodging too long, softens the clay so much, that the whole falls down into the bottom of the drain.

I am at present trying, in a few drains, a more simple plan, which has, I understand, been found to succeed well enough on one of your own farms at Drip. It has not, however, yet stood the test of time, and, therefore, I cannot venture to recommend

it, though I am inclined to think pretty favourably of it. It consists merely in cutting the strongest clay, the field to be drained affords, into masses of the shape of the turfs formerly described, and putting these into the drains without breaking them, exactly as is done with turf. In order to give this method as good a chance of success as possible, I think it should be done in wet weather.

Wood has been used in a few cases in this neighbourhood in the following manner, but I have not tried it. From the thinnings of fir-plantations, trees have generally been chosen of such a size as, when sawn or split longitudinally into two, or sometimes into four, the segments are of the dimensions required, that is, about 4 inches in diameter. A great objection to this is the expence, which is almost double that of the method with turf. Mr Murray made a trial of peat cut into the shape of the turfs, and dried nearly as if intended for fuel. This succeeded very well, and will, I have no doubt, prove very durable; but it is expensive. I have only heard of one trial made with stones. I do not think it can answer, and there are few situations in our carses where it is practicable, for want of stones fit for the purpose. Indeed, I am so much convinced that good turf is preferable to every thing else, that I recommend to all my tenants, any part of whose farms it is intended to drain, to keep a few ridges of the strongest clay-land they have in pasture for at least three years, so as to be provided with abundance of good turf, when it comes to be

wanted. There are not many farms where a small quantity of good turf cannot be got in the mean time from the sides of ditches, or of roads, or from waste corners, which are still in too many farms suffered to remain,—a just source of reproach to our farmers.

Mr Thomas Hannay of Grange of Cree, in Wigtonshire, was the first person who practised wedge-draining in Scotland, and has generally been esteemed the inventor of it. He certainly was so, in as far as regards the using a wedge of turf, in my opinion, a very important part of the process. In the Farmer's Magazine for August 1815, (vol. xvi. p. 261.), Mr Hannay gives a very distinct account of his method of draining, which he candidly acknowledges he was led to by reading in the fourth volume of the same Magazine, p. 278., an account of the Essex method of underdraining, which is not materially different from our practice, in as far as respects the cutting the drains, though very inferior as to the filling, which in Essex was then done with straw. He also mentions, that Mr Boyd of Mertonhall had begun the practice of under-draining much about the same time that he did, without either party being aware of the operations of the other. Under-drainings, nearly similar to those at first made by John Blair, are still used in Cambridgeshire, and, I believe, in other parts of England; but the mode of wedging the turf firmly between the sloping sides of the drain, instead of making it rest upon shoulders, is unquestionably an important im-

provement in point of durability, for these shoulders have been often found to give way under the pressure of wet earth, in which case the whole sinks to the bottom of the drain. In point of economy, the saving of expence, both as to the quantity of clay to be moved, and as to the quantity of turf required, is obvious.

A question of far greater importance than the name of the inventor, or the date or place of the invention, has often been asked,—How long are wedge-drains likely to last? This question we are not yet perhaps fully able to answer; but those executed near nine years ago at Polmaise, are still running very well, and Mr Murray tells me, that some in Wigtonshire are still quite clear, which were cut several years before his. They will not, however, last nearly so long, where they are not at least 3 feet deep, or where the clay is not very stiff; indeed, where it is mixed with sand in any considerable proportion, or approaches to the nature of loam, I would not advise their being attempted. The method of pipe-draining, described and recommended by Mr Hannay, has not been tried in this part of Scotland, but certainly merits a trial in soils too sandy for wedge-draining, if proper turfs for the purpose can be got.

Another question equally important is, What may be reckoned the average increase of crop in consequence of the operation? This must obviously be very various in proportion, as the land was more or less wet before it was drained. I have never yet

seen a field of carse-land that was not wet enough to be much the better for wedge-draining, and Mr Murray estimates the average improvement at two bolls per acre, besides an immense increase in the quantity of straw. He had this year sixty threaves of barley per acre on wedge-drained land. I must, however, remark, that the improvement has always appeared to me more striking in the first two or three crops than afterwards, and the reason, I apprehend, is, that although the drains remain perfectly clear, the clay above them becoming gradually more compact, the surface-water does not get down into them so quickly after a few years as it did at first.

The price I now pay for cutting wedge-drains 3 feet deep, including the cutting of the turf and putting it in, is 4d. per rood of 20 lineal feet, and I am at the expence of carrying the turf from the place where it is cut, and laying it down close to the drains in a regular line, so that the person employed by the contractor in putting it in, can easily reach it without coming out of the drain. I know that the work can be done a little cheaper, but I know also, that where it has been done too cheap, it has not in general been so well done, and the durability in a great measure depends on the work being properly executed. This is, I believe, the same price that Mr Murray now pays. At first we both paid a good deal more, but an expert workman will make good, though not extravagant, wages at the rate I have mentioned. Where wood is used

as a wedge instead of turf, about a ½d. per rood will be saved as the price of cutting the turf; while, on the other hand, the expence of the wood must, of course, vary considerably according to local circumstances; but where it has been tried in this country, and sawn with a saw-mill, I believe it has cost from 13d. to 14d. per chain of 74 feet. The expence of draining per acre, must, it is obvious, depend on the breadth of the ridges. Where these are of 15 feet, the most common breadth in our carses, it will cost about L. 2, 17s. per acre; but in wedge-drained land, I think the ridges may be advantageously made 18 or 20 feet broad, which will of course be attended with a proportionate reduction of the expence of draining. Mr Murray is of opinion that the improvement on the first crop, where that crop is wheat, will nearly pay the expence. Certainly in all ordinary cases, the improvement on the first two crops will do more than pay it. Indeed, I have been told that a very shrewd and intelligent farmer on an estate in my neighbourhood, says, he is convinced that it would be for the interest of a tenant to wedge-drain, although it were ascertained that these drains would only last two years. He is himself draining extensively.

Hitherto, as far as I know, wedge-draining has not been practised any where in Scotland except in Galloway, and for about twenty miles along both banks of the Forth. It is rapidly spreading in this neighbourhood, and we are unquestionably very

much indebted to Mr Murray for having introduced it amongst us. I have not a doubt that it would meet with similar success in the Carse of Gowrie, were it once tried there; but there are not, I apprehend, a great many other situations in Scotland that are equally fit for it. What are called clay lands in England, containing generally an admixture of sand, gravel, or stones, are not at all adapted to it. I don't know if it is practised any where in England, but it would succeed wherever the Essex method answers. An idea has prevailed that it was brought to Scotland from Ireland, but this is a mistake, arising, I presume, from the circumstance of the work being chiefly executed in this part of the country by Irish labourers, who have been trained to it in Galloway.

At first we were obliged to have the tools, as well as the workmen, from Wigtonshire; but they are now pretty well made by several smiths in this neighbourhood, and many of our own labourers are becoming expert drainers. A set of spades and a hoe made in the neighbourhood of Wigton, and delivered in Edinburgh or Glasgow, used to cost about L. 1 Sterling.

I have now, my dear Sir, given you all the information that I am possessed of on this interesting subject, and I fear you may think I have given you much that is unimportant, and a great deal of what I have said, I am sure was known to you before. My letter has run out to a greater length than I expected, but the short time prescribed for the communication does not admit of my condensing it, or

arranging it better. You will of course curtail as much of it as you may consider useless, before communicating its substance to the Society, and should any part of it appear to you, or to others, obscure, I shall be most ready to explain it as far as I can. I remain, with great regard, My dear Sir, very faithfully yours,

CHA[s]. ALEX[r]. MOIR.

LECKIE,
19*th December* 1823.

ON THE

IMPROVEMENT OF KELP

BY

ANDREW FYFE, M. D. F. R. S. E.
LECTURER ON CHEMISTRY, EDINBURGH.

At a time when the Kelp Manufacture is threatened with a total overthrow, from the introduction of alkaline matter, by the decomposition of sea-salt, I conceive that no apology is necessary, for taking up the time of the Society, in laying before it a few remarks, which, it is to be hoped, may tend to the improvement of this important article.

Since I had the honour of addressing the Society on this subject, my attention has been frequently recalled to it, and the experiments in which I have been lately engaged, afford strong grounds for believing that I have at last found out the cause of the inferiority of kelp to barilla, with respect to the quantity of soda for which they are prized.

The experiments detailed in my former paper, led me to suppose, that there ought not to be any real difference between these articles, as the origin of the alkali seemed to me to be the same in both;

consequently, that the inferiority of the latter, depended solely on the mode of manufacture.

The saline contents detected in sea-weed, by chemical analysis, I have there shewn to be sulphate of potass and muriate of soda; but that, after incineration, they are sulphate of potass, muriate of potass, carbonate of soda, and soda in union with sulphur; from which I have inferred, that the vegetable matter is partly destroyed by the heat, furnishing carbonic acid, and that the remaining part decomposes the sulphuric acid of the sulphate of potass, part of the sulphur being dissipated, and part retained, to form the sulphuret of the alkali. Though sulphate of potass is thus decomposed, potass is not found in its free or carbonated state in kelp; for, as the weed always contains muriate of soda, the potass must, from its greater affinity for muriatic acid, decompose the muriate, combine with its acid, and set its alkali free, which is left partly uncombined, partly in union with the carbonic acid formed by the combustion of the weed, and also with the sulphur disengaged from the sulphuric acid.

That this is the case, seems proved by the experiments on sea-weed exposed to the action of water, by which the quantity of alkali was considerably diminished, but which was restored by soaking it in sea-water before burning, the saline substance having been imbibed, so as to yield alkali by its decomposition. Besides, it is well known that weed exposed to rain always affords a kelp of little value.

That the whole of the soda is not liberated from its state of combination, in the process to which the weed is submitted for converting it into kelp, is proved by the operation to which soap-makers subject it, for preparing their black ash, which is merely exposing their waste to the action of heat, along with carbonaceous matter, by which more free soda is obtained.

While reflecting on this subject, it occurred to me, that, by treating kelp itself in a similar manner, the quantity of alkali might be greatly increased. I have, accordingly, performed a number of experiments with this view,—indeed every kelp that has been sent me for analysis for a considerable time past, has been submitted to this process, and in every one I have succeeded in rendering the alkali in muchgreater quantity; and the less valuable the kelp, that is, the less free soda it contains, I have in general found that the greater is the quantity of soda added. It is unnecessary to take up the time of the Society in detailing all the experiments I have made. I will content myself with two, in which, though the kelps were by far the best I have yet submitted to analysis, I have succeeded in increasing the proportion of Soda. 400 grains of kelp from Ulva, containing 9.4 per cent. of soda, were exposed for some hours to a red heat along with saw-dust, after which it yielded, by the same mode of analysis as that to which it was first subjected, 10.5 per cent. of alkali.

In the other trial, 400 grains of kelp, prepared on the estate of Lord Macdonald, by a particular process, which contained 7.5 per cent. of soda, were treated in the same way, after which they afforded no less than 12.2 per cent.

From the foregoing statement, it may be concluded, that kelp may be materially improved, by submitting it to heat with carbonaceous matter, before it is applied to any purpose in which it is valued for its free alkali. This, it may be said, is the same as soap-makers have been in the custom of practising; but a few moments' consideration will shew, that though in principle the same, yet it differs from it materially in point of economy, We are not to consider a kelp that contains 4 per cent. of soda only double the value to soap-makers of one containing 2 per cent. because, to extract the 4, requires the same quantity of lime, the same fuel, labour, and wear of apparatus as for the 2; so that it is nearly treble the value. In the mode in which kelp is generally employed, it is first deprived of its free soda, and, after evaporating the spent ley to dryness, they are converted into black ash, and again submitted to the process for extracting the alkali; so that if the kelp originally contained 3 per cent., and the ash also yielded 3, there is double the quantity of lime, fuel, labour, and waste of apparatus, that there is any necessity for, because, having subjected the kelp to the process recommended, the 6 of soda may be extracted by one solution and liming.

On submitting my ideas on this subject to Mr Auld, soap-manufacturer in Leith, I was gratified to find, that he had been induced, at the suggestion of some soap-makers in England, to adopt nearly a similar mode. It consists in exposing kelp along with coal, and the spent saline matter of their operations, to a strong heat. This is, however, constantly adding to the quantity of materials to be heated, without getting any additional soda from them; besides, their presence may perhaps prevent the action of the carbonaceous matter on the kelp. The mode I would recommend is merely to reduce the kelp to coarse powder, mix it with culm or coak also reduced to powder, and expose it to a high temperature for some hours, frequently stirring, to bring the whole of the alkaline salts into contact with the carbon, and, at the same time preventing, as much as possible, any current of air over the surface of the melted matter. It is then, while fluid, to be drawn off into pits.

The quantity of alkali we have thus seen, may be greatly increased by a very simple process; but it would be of great importance to be able to bring kelp up to its utmost in the first operation to which the weed is subjected. On examining kelps, I have always found those rich in soda to be closer in their texture, and almost free from admixture of charcoal, shewing that the whole of that in the weed has been consumed by the combustion, and in decomposing the salts. This, and the circumstance of more free alkali being obtained by a second burning with

charcoal, makes me suspect either that there is a deficiency of carbon in the weed, or, which is more likely, that, in the process of kelp-making, the greater part of it is consumed by the heat, before it begins to act on the salts, and hence little soda is obtained. Experiments which I have performed on a small scale, seem to me to warrant this conclusion. It is unnecessary to detail them; I may merely mention, that when equal quantities of weed were heated, one exposed to the atmosphere, the other in a close vessel, so as to prevent the access of air, and consequent burning of the vegetable matter, the latter yielded nearly twice as much soda as the former.

Whether there is originally too little carbon, or whether it is consumed during the process, is not of much consequence, as the remedy is the same in both cases, and I conceive that this follows from what has been said in a former part of the paper. It has been already stated, that I have been enabled to bring up the quantity of alkali, even in those kelps which have been manufactured with all possible care, in one to 10.5, and in another to above 12 per cent., merely by submitting them to heat with an additional quantity of carbon. I conceive, then, that all that is necessary in kelp-making, is to prevent, as much as possible, the consumption of the vegetable matter by the access of air, and that after the process is finished according to the present mode, successive quantities of saw-dust, culm, peat, or any carbonaceous substance, should be added, and the

whole well stirred, till the alkaline sulphates are decomposed.

Two methods may be followed in carrying on this operation. The kelp, before it is allowed to cool, may be mixed with the other substance in the kiln in which it has been prepared, and the heat thus kept up till the decomposition is effected; or, after it has become cold, it may be reduced to powder, mixed with the vegetable body, and heated in a furnace. I believe the preferable plan, or at least the one most likely to be followed, is to mix the peat or other vegetable substance with the melted matter in the kiln, as in this, though more of it may be consumed by the combustion necessary for keeping up the heat, yet no additional apparatus is necessary, and the labour of breaking down the kelp after it has become consolidated, and reburning it, would be avoided.

It is not to be expected that I can enter into any detail as to the quantity of carbonaceous matter to be added, or the manner in which the process is to be carried on: I merely wish to point out a mode, by which I have every reason to expect, that kelp may be manufactured, which will compete with barilla, with respect to the quantity of soda.

Though I have succeeded, in a small scale, in increasing the soda to so great an extent, it must not be supposed, that, when prepared in the common way, kelp will be made having the same proportion of alkali; but taking the average of soda to

be about 3 or 4 per cent., if this can be doubled, a very material point is gained, because, with this quantity, it will at all events, even though inferior in real value, compete with barilla, which brings from three to four times the price.

One thing I consider the preceding remarks clearly to establish, that the proportion of alkali may be greatly increased after the kelp has been manufactured, and if this be allowed, I cannot see how it can fail to succeed in the first operation, for wherein consists the difference, of reducing kelp to powder, and heating it with carbon, and of at once, when fluid in the kiln, mixing it with the same matter, and continuing the application of the heat? They are one and the same, the result ought therefore to be similar.

This subject is well-worthy the serious consideration of the Society. It is through their support that the plan now proposed may have a fair trial, and should it meet with their approbation, and ultimately succeed, I will consider myself amply repaid for the time and labour I have bestowed, if my efforts shall be the means of warding off the ruin now impending over the staple commodity of the Highlands and Islands of Scotland, by which one great source of subsistence must be ultimately withdrawn from the poorer part of their population, and the incomes of many of their proprietors be considerably reduced.

ON THE

PREPARATION

OF THE

ZOSTERA OR SEA-GRASS,

IN ORKNEY.

In a Letter from JOHN TRAILL URQUHART, ESQ. of Elsness.

Elsness, by Kirkwall,
October 22. 1823.

SIR,

INTENDING to become a competitor for the premium offered by the Highland Society of Scotland for the preparation of the marine plant Zostera or Sea-grass, I inclose herewith, in conformity with the directions contained in their list of premiums, a few brief notices respecting the plant, with the methods used by me in washing, and drying, and preparing it for market; together with an affidavit of the quantity sold, and price obtained; which will be farther corroborated by a certificate from the purchase Mr

Johnston, which will be lodged with you by my agent, George Veitch, Esq. W. S.

I shall only add, that should the Society see fit to consider me entitled to the premium, a piece of plate, of the same value, if not contrary to their rules, would be more gratifying to my feelings. I have at present nearly three tons of the sea-grass on hand, prepared in a superior manner, which I am very anxious to get to market before the 10th November. When I had the pleasure to meet you in Sanday last autumn for a few minutes, you suggested the idea of my preparing some of this grass, with a view to the introduction of a useful manufacture; and I have since adopted your suggestion, as you see. I am, Sir, &c. &c.

JOHN TRAILL URQUHART.

To CHARLES GORDON, Esq.
Dep. Sec. Highland Society, Edin.

The marine plant Zostera or Sea-grass is found in abundance in all those bays of the Orkney Islands which are not exposed to the immediate fury of the ocean; and is there known by the name of Mella or Mallow.

Wherever the bays are land-locked, banks of sand and mud accumulate, which appear to be held together principally by the roots of this plant, which are strong and succulent, and throw out numerous lateral fibres.

The zostera generally grows at such depths as to be left nearly dry by the ebbing of spring-tides.

The leaves remain attached to the stem until the month of September; and during the autumn, and beginning of winter, are thrown ashore in large quantities.

As this plant floats near the surface of the water, it is always driven *before* the wind,—unlike the other marine plants of these islands, which (with the exception of Fucus vesiculosus, whose air-vessels keep it afloat) remain near the bottom, and are forced ashore, *against* the wind, by the ground-swell, or reflux of the waves.

The sea-grass is used by the inhabitants of these islands as manure for their fields, for which purpose it is either gathered into heaps with other marine plants, and allowed to ferment before being applied to the land, or formed into compost with earth, litter, &c.; in both which ways it is found to answer well.

It is also used by the poorer classes of labourers or cottars as thatch for their houses, and in this way forms a good defence against the violent winds and heavy rains of their rude climate, for two years.

Its application as a substitute for horse-hair, in stuffing mattresses and furniture, was unknown in these islands, until the attention of a few individuals was directed to it, by the offer of a premium by the Highland Society of Scotland, for its preservation for that purpose, and with a view to its introduction as a useful article of manufacture.

The list of premiums offered by the Society happening to come into the hands of the writer of this brief and imperfect sketch, during last autumn, he conceived he might employ some of his people profitably in collecting, washing, and drying the grass for sale. The season being unluckily too far advanced for procuring any large quantity, he prepared, by way of experiment, 1 ton 3 cwt. 14 lb., which his agent has since sold to the manager of the Asylum for the Industrious Blind at Edinburgh, at the rate of 12s. 9d. per cwt. On this quantity, which grossed L. 14, 15s., his nett profit did not exceed L.8; but this partly arose from inexperience in the mode of preparing it. On a quantity amounting to nearly three tons, which he has got ready for market within these few weeks, the expences of washing, drying, and picking, have not amounted to more than half of the charge on the smaller quantity first noticed. The first was carefully washed twice in vessels filled with fresh water, and dried quickly, and then any sea-weed that had floated ashore with it, picked out when dry. The last was carted to a fresh-water lake, and steeped during a week, when it was taken out, and picked by boys and young girls, while spread wet upon the ground. If properly steeped, exposure to drought for one day will make it sufficiently dry for packing. When dry, care must be taken, if the weather is windy, to gather it into heaps or cocks, otherwise it may be blown away, being then extremely light. The first quantity prepared was sent to market in large bags of sacking, of

the size of wool-packages, very hard packed, yet that small quantity required fourteen bags to contain it. The last has been twisted into ropes, of the thickness of a man's waist, and then compactly made up in nets, formed of ropes made of bent-grass.

The zostera is a plant of a very imperishable nature, and may be kept for any length of time in fresh or salt water, without any apparent decay. Should a sufficient demand arise for this grass, at a fair price, any quantity could be collected in the Orkney Islands that the market could require, and it would furnish a species of labour well adapted to old people, past hard work, and young people not yet able for hard work. The wages generally given for such sort of work at present, is 6d. per day, which is more than can be earned by plaiting straw, the staple employment of young people in the Orkney Islands.

At Saville, in the Island of Sanday, before the Reverend WALTER TRAILL of Westove, one of his Majesty's Justices of the Peace for the County of Orkney,

Appeared JOHN TRAILL URQUHART, Esq. of Elsness, who made oath, That between the months of September 1822 and September 1823, he prepared, upon his estate of Elsness, in Sanday, by washing and drying, the quantity of twenty-three hundred weight and fourteen pounds of sea-grass, or mella (Zostera), which he consigned for sale to George

Veitch, Esq. W. S. Edinburgh, by whom it was sold to the Manager of the Asylum for the Industrious Blind at Edinburgh, at the rate of Twelve shillings and ninepence per hundred weight.

JOHN TRAILL URQUHART.

Sworn before me, at Saville, 20th October 1823.

WALTER TRAILL, *J. P.*

ON THE PRESENT STATE OF THE SHEEP-HUSBANDRY IN ORKNEY.

By James Baikie, Esq. of Tankerness.

The Orkney sheep (Ovis aries, Lin. Syst.) is believed to be of the same breed as that of Shetland, the Faroe Isles, and Iceland. They vary in size according to the care bestowed on them. In some of the hilly islands of Orkney, they are permitted to roam about, a prey to dogs and eagles, and subject to the various distempers peculiar to sheep, deprived of the chance of any remedy being attempted; and in this wild and neglected state, the weight of the entire carcase seldom exceeds from 25 to 30 lb. Their flesh is, besides, coarse and dry, and from their proneness to feed largely on sea-weed, of a disagreeable flavour, which some people have, very inaptly, supposed to resemble that of venison. When, however, they are more attended to, their weight

greatly increases, nearly one-fourth, and their mutton, when the pasture is so ample as to render their visits to the sea-shore unnecessary, is excellent. The quality and quantity of their wool, too, reap great advantages from an improved management, so as sometimes to reach three merks or four pounds in weight; while, in the wild and neglected state of the animal, it seldom exceeds 1½ lb. The Orkney sheep meets with the best treatment in the smaller and flat islands, where they are constantly under the eye of their owners, who either keep them tethered, that is, fastened, on those parts of the island where the pasture is most suitable, or put them in adjacent uninhabited islands, called Holms, where, when their number is properly limited, so as not to overstock the pasture, they seem to thrive better than in any other method at present in practice in Orkney. They here attain their greatest size and weight; their wool is finer, and more plentiful; and their fecundity remarkable, as two and even three lambs are common at a birth. The holm is also peculiarly adapted for the ewe during the lambing-season, (the months of April and May) especially if so near the adjacent inhabited island, as to enable the farmer frequently to visit his flock, and thus keep at a distance the eagle and the corby, (Corvus Cornax, Lin. Syst.), which latter is the greatest enemy the newly dropped lamb has. In his visits during these months, the farmer is never attended by his dog, as the fright occasioned to the ewe about to lamb, by the appearance of an animal for which

she has naturally so great a dread, often proves fatal. The sheep are generally shorn in the beginning of June, and the scissars have of late got into much use, instead of the former barbarous method of tearing off the wool with the fingers. In no case, as yet, has it become the practice to wash the Orkney sheep before being shorn, and it will be difficult to convince their owners of the advantages arising from this method. The wool is divided according to the different colours, white, gray, tawny, and black, and washed in a burn or lake, and then spread to dry on the grass, as soon after the sheep are shorn as possible; the finer parts of the fleece, such as grow on the breast, being first carefully separated from the coarse, when required for any particular purpose, such as fine stockings, gloves, &c. The operation of converting the ram-lambs into wethers, is also performed at the time the fleeces are taken from their mothers, as, if they are permitted to be more than a few weeks old, the lambs generally die under the operation. This may, however, arise very much from the unskilfulness of the operators, as there are no professional shepherds in Orkney. When no appearance of scab makes such a thing necessary, the Orkney sheep are never smeared, which is alleged, in some degree, to account for the softness of their wool, as it is observed, in the rare instances where this remedy has been applied, that the wool grows coarser and harder for some time afterwards. When the sheep are kept in holms, this disease seldom, if ever, makes its ap-

pearance. Many of these holms are so small, and so much exposed to the sea-breach, as to render it dangerous to leave the sheep on them after the month of November, when they are removed to the adjacent island, and permitted to roam at large, till the following April or May, at which time they are returned to the holm during the summer and autumn. As winter-herding is now beginning to be introduced into Orkney, the practice of permitting the sheep to wander about during the winter months must soon necessarily have an end; and this hitherto much neglected, but useful animal, will probably be better fed and attended to than heretofore. The people, however, are generally averse to what they deem a hardship, and rather than submit to winter herding, they speak of entirely getting rid of the native breed of sheep, and substituting the Cheviot breed, which is found more tractable, and which some of the farmers already have accustomed to pasture with the cattle, and to accompany them on their return to be housed at night.

In a holm, within a few hundred yards of the island of Egilshay, I propose to keep a small flock of Orkney sheep, with a view to try to improve both the flesh and the wool of this animal. This flock has been bred in this holm, and formed a part of what is called the *steelbow* of a farm in Egilshay. I intend to confine its number to between thirty and forty, and I herewith send a portion of the fleece of the ram I propose using, partly from his compact figure, and partly because his wool is tawny,

which is in great request among the people for clothing, as the expence and trouble of dying the cloth of a dark colour are thus avoided. The specimen of the ram's wool now sent is unwashed. I also send a specimen, as required, of one of the ewes to be kept for this experiment, though I do not think it finer than that of most of the others. I subjoin the ages of 22 ewes, which I intend to use n this experimental flock. The oldest is eight years old, and retained because she has every year had two fine lambs. There are, besides,

Two white ewes, four years old.
Four do. do, three years old.
Six do. do. two years old.
One tawny, and two grey ewes, two years old.
Two white do. one year old.
Four ditto ewe lambs of this year.
And one tawny ram three years old.

With these, I propose to compete for the premium offered by the Highland Society of Scotland for 1825, for the most successful attempt to improve the Orkney or Shetland breed of sheep, and shall, if required, send an attested report of my experiment in 1824. The holm or island I have selected for the purpose is Kilie Holm, containing about six or seven acres of pasture, on which upwards of 100 sheep have hitherto been kept, during the months of summer and autumn. Overstocked as this holm has hitherto been, it has never failed to fatten some of these sheep sufficiently; and as I intend to confine my experimental flock to 40 or 50 at the ut-

most, I am in hopes they will greatly improve in size, and in the quality and length of the wool. In the month of November they will be removed to the neighbouring island of Egilshay, to a small farm about a quarter of a mile from the holm. There they will remain during the winter months, under the care of a shepherd, whose house is built on that part of Egilshay nearest to the holm. They will at night be driven into a small square inclosure called a *sheep-crew*, and, when the weather is bad, they will be housed, and have turnips and hay, (both of which are somewhat a rarity to the Orkney sheep), given to them.

JA. BAIKIE.

The statement above, of the present Orkney system of managing sheep, appears to me quite correct, and I have little doubt of Mr Baikie's proposed improvement greatly bettering both the wool and mutton.

WILLIAM TRAILL,
Mem. H. Society.
WM. SINCLAIR, *J. P.*

DESCRIPTION

OF THE

ODOMETER,

EXHIBITED IN JANUARY 1821, AT A MEETING OF THE HIGHLAND SOCIETY, AND PRESENTED TO THEM BY MR HUNTER OF THURSTON.

(*Plate VIII.*)

THE wheel A is made of light iron, and measures two yards in circumference, being divided by six spokes into feet. One spoke must be painted white.

The handle is divided at C, like a fork, and embraces each end of the axis by its elasticity. Through the axis is a hole, into which the end H of the Way-wiser fits, and is held fast by a nut D.

The way-wiser consists of a frame FG; F being hollow, to receive a perpetual screw H, a part of which is visible near the index M. At the other end of the screw is a nut I, which keeps it in its place. The screw turns two brass concentric cog-

ged wheels K and L; K conceals the scale of L, except where a piece is cut out, leaving an index at the beginning of the scale of K, and which in the drawing points to 78 of L.

The scale of K is numbered towards the left, and that of L to the right.

The wheel K has 100 cogs or teeth, and L 101; consequently, as the same endless screw turns both wheels, it is evident, that when K has made a complete revolution of 100 teeth, L will also have made a revolution of 100 teeth; and the index of K will point to 1 of L, because L has 101 teeth. After a second revolution, it will point to 2, and so on; the number it points to, marking the number of revolutions; each revolution shewing 100 turns of the iron wheel A.

Accordingly, A measures 6 feet, or 1 turn; K 100 times 6 feet, or 600 feet, or 1 revolution; and L 101 times 600 feet, or 60600 feet, equal to nearly $11\frac{1}{2}$ English miles,—the range of the instrument.

880 turns of this wheel make a mile.

It is advisable always to commence with the way-wiser set at 0 or zero; to do this, take out the screw in the centre, when the brass wheels K and L can both be set at zero, and the screw replaced. Set the wheel A upon the ground, with the white spoke undermost, and fix the way-wiser into the wheel, by means of the nut D, always observing to put it on the left side, as shewn in the Plate at E.

At any period of measuring, you can tell exact-

ly how far you have gone, and proceed without again setting the way-wiser at 0.

Suppose, as in the drawing, the spoke No. 2. at the ground, the index M pointing at 26 of K, and the index of K pointing at 78 of L; then the distance measured is 7826 turns of A and two feet; and as A measures 2 yards*, $7826 \times 2 = 15652$ yards, to which add the 2 feet.

In reading off, particular care must be taken always to read the large figures (viz. those on the wheel L) first, and afterwards to add the small fi-

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* The wheel A being made to measure one yard, would be much simpler, but it would be inconveniently small, and would reduce the range of the Instrument to 10,100 yards; whereas, by making it 2 yards, there is only the trouble of multiplying by 2, and the range is 20,200 yards, or almost $11\frac{1}{2}$ miles: Or, if it is only required to measure yards, the way-wiser may at once have its scale marked 20, 40, 60, &c. instead of 10, 20, 30, &c. and then it will not be necessary to multiply by 2; but, for my own use, I have preferred a wheel measuring 6.6 feet, or $6\frac{6}{10}$, which is exactly the tenth part of an English chain; and my iron wheel is divided into 10 parts, so that all my calculations are in decimals. If the way-wiser stands as before at 7826, and the spoke No. 2. on the ground, then the measurement is 7826 turns and $\frac{2}{10}$, written 7826.2 turns, equal to 782.62 chains, equal to 78.262 furlongs, which may also be read 78 furl. 2 ch. $6\frac{2}{10}$th turns; so that, by using decimals, there is no more calculation required than if the wheel measured 1 yard.

800 turns of this wheel make a mile; and it measures $12\frac{5}{8}$ miles.

Any person preferring Scotch measure, may have a wheel made to measure 7.4 or $7\frac{4}{10}$th feet.

gures (viz. those on the wheel K); and, if the figures on K amount to less than 10, a 0 must be prefixed, so that K shall always shew two figures; for instance, L being at 46, and K at 4, the sum is 4604. The easiest way to guard against error is to read 46 and add the word hundred; thus, forty-six hundred and four, and not four thousand six hundred and four.

It is hardly necessary to point out the advantage of having such an instrument. No country gentleman, who takes the smallest charge of his own affairs, should be without one; as, by merely walking from one end to the other of any road, hedge, wall, ditch, &c. with the Odometer, *(which is not more troublesome than a walking-stick)*, he can tell the length of it much more correctly than by a measuring chain, which, to say the least of it, requires two honest men, one at each end, and who must be both paid for their trouble; whereas the gentleman himself, whose honesty cannot be doubted, as he is not likely to cheat himself, can, at no expence, measure with this instrument at least four times as quick as those with the chain, who have it also in their power to mismeasure, if I may use the expression, six inches every time a peg is put into the ground; but its principal uses are to check measurements already made, and to measure off the size of any proposed improvements, such as plantations, gardens, &c.

A third brass wheel of 102 teeth being added to the way-wiser, gives it the astonishing power of

measuring 1,030,200 (upwards of one million) turns of *A*, without increasing the size of the instrument.

My wheel of $6\frac{6}{10}$ feet will thus measure nearly 1300 miles. But the distance cannot be read off without the following Formula:

Let K have 100 teeth,

L 101

N 102

Then, $L^* - N \times 10100 + 100\,L^* + K$ is the number of turns of *A*.

This would be very useful in large Manufactories, and, by means of observing the *time* which the Instrument takes to complete its range, it might be allowed to commence again two or three (perhaps twenty) times, without danger of a mistake.

Mr HOWDEN, Watchmaker, No. 9. South Bridge, Edinburgh, makes the Odometer complete, with one iron wheel, for L. 2, 2s.

P. S. I have lately succeeded in finding a method of attaching the Instrument to the wheel of any carriage, and thus to measure the road travelled, with the greatest correctness, and at any *rate* of travelling.

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* If L be less than N, add 101 to L.

DESCRIPTION

OF A

NEW STEAM-VESSEL;

WITH ITS MACHINERY AND MOVING POWER CONTAINED ENTIRELY WITHIN THE VESSEL.

ACCOMPANIED BY A MODEL CONSTRUCTED UPON THE PROPOSED PLAN.

By Mr Robert Wight *junior*, Accountant in Edinburgh.

The method here proposed is exceedingly simple, and is accomplished by introducing and conducting the water through the vessel, by means of a *water-passage* or *channel*, cut through the bow, and passing direct through the centre of the vessel, until it terminates at the stern. One paddle-wheel in the centre of the vessel, is driven by a steam-engine, or other first mover, and acts upon the water in the channel, at a proper distance from the bow. The water-channel in the accompanying model is of the same depth and breadth from stem to stern; and although it has been suggested, that, by making it

gradually wider from the wheel to the stern, the hydrostatical pressure of the broken water, which is there raised above its natural surface, would be exerted obliquely, in assisting to propel the vessel forward; yet, by other experiments, since the model was finished, this result has not been observed to take place.

The *breadth* and *depth* of the water-channel will be regulated by the *breadth* and *diameter* of the paddle-wheel, whose dimensions depend on the size of the vessel. By a series of calculations and corresponding experiments, one-third of the vessel's *beam* will be the breadth of the paddles, and of course the water-channel must be as wide as to allow the paddles to work freely. The depth of the channel must be such as will admit a sufficient quantity of water to answer the *dip* of the paddles, with three or four inches clear between them and the bottom of the channel, and also allowing about nine or twelve inches above the surface of the water, for a free passage to the air. Thus, if the paddles dip 24 inches, and are 3 inches clear of the bottom, and if there be 9 inches allowed above the water, the whole depth of the channel will be only 3 feet.

An inspection of the model will explain many other particulars of this plan, which may occur in judging of its practicability on a great scale, and in the mean time seems to render more minute description unnecessary.

The advantages arising from the proposed method appear to be numerous; and, among these, the following seem to be important, viz.

1st, The outside paddle-wheels are entirely done away, thereby reducing the present awkward and inconvenient breadth of the vessel, and of course diminishing nearly one-half of the resistance presented to the atmosphere, by the projections and coverings of the outside wheels, as well as obviating the danger of these wheels being carried away by a heavy sea, upsetting small boats, &c. &c.

2d, The great agitation in the water occasioned by the outside wheels, will be diminished about two-thirds; and while the agitated water by outside wheels is made to *diverge* from the vessel's sides, that which is caused by the proposed method is confined to a *straight line* in the *wake* of the ship; thereby materially, if not entirely, reducing its destructive effects on the banks of rivers or canals.

3d, The whole machinery and moving power are contained entirely within the natural sides of the vessel, and are thereby at all times completely protected from the effects of bad weather, while their efforts to propel the vessel will remain nearly unaltered, in all the various positions to which she is subject during her progress.

4th, The machinery will be less complicated, and of course much cheaper, and less liable to accident, than that employed at present.

5th, A vessel upon this new construction being provided with masts and sails, can be easily converted into an ordinary *sailing* ship, in the short space of a quarter of an hour, and that at all times, and during any weather, thereby causing a great saving of fuel, either when the wind is favourable, or where it may be necessary to lay the vessel to; an advantage which cannot be obtained in the method now practised, without the paddle-wheels creating a very serious obstacle to the ship's progress through the water.

6th, Judging from the velocity of the model, which is only about 27 inches long, and goes on an average rather more than 65 feet in 40 seconds, (being a greater velocity than that obtained from any other model of her size driven by mechanism), there appears every reason to believe, that steam-vessels on this new plan will sail much faster than the present, and that without any addition to the power of the engine.

7th, From these considerations, it seems obvious, that the proposed plan is equally applicable to *canal, river*, or *deep-sea* navigation.

Note.—As the principal, or rather the only known disadvantage attending this plan, is the partial reduction of the *stowage*, it may be here mentioned, that this inconvenience is greatly obviated by the *shape* which seems best adapted to vessels on this new method; for in place of having a very *long clean run*, a vessel on this plan may be safely made of the *same shape and size* at the stern as at

the bow. This doctrine is rather at variance with *received* opinion, in regard to *sailing vessels*, but an inspection of the model, and an attentive consideration of the subject, will best explain, that a *long clean run* would be rather detrimental, while the equality of shape and size now suggested, would tend materially to increase the vessel's speed.

ROBERT WIGHT.

Edinburgh, 9th August 1821.

NOTE

By Mr STEVENSON, Engineer,

Regarding the Vessel described by Mr WIGHT *in the foregoing Paper.*

A Committee of the Highland Society attended certain experiments made in the Wet Docks at Leith, and upon the Edinburgh Union Canal, with a boat measuring about 25 feet in length of keel. This boat, which may be considered as a large model, was constructed with a square water-tight case, extending from stem to stern, forming a compartment for the passage of the water, and the action of a paddle-wheel, which, on the occasion alluded to, was worked by four men, with two common hand cranks,—with which the boat, carrying 26 people, was propelled at the rate of about five miles per hour. In so far as these trials were proceeded with, the impressions upon the gentlemen who attended Mr Wight's interesting experiments, were, that the removal of the paddles from the sides to the middle of the vessel was ingenious,—and that the application of this principle to canal-navigation might be attended

with beneficial effects, as the wheels could not then impinge immediately upon, or injure the sides of the canal. At the same time, it is evident, that much of the stowage and accommodation of the vessel would be occupied by the introduction of the water-tight compartment, with its connecting apparatus. Doubts were also entertained as to the application of this plan for deep-sea navigation.

It may be noticed generally, in providing for the velocity of vessels employed in inland-navigation, that it seems unnecessary to attempt to increase their speed beyond the rate of about four miles an hour. For, unless the canal is very capacious, the velocity of the boat must unavoidably produce that action and re-action in the water which is so highly detrimental to the banks. By Mr Wight's plan, the agitation of the water is more confined to the central parts of the canal, and in giving motion to a boat, with an apparatus on board for propelling her, the *cross-purposes* of the track-horse and boat's rudder would in a great measure be avoided. The common mode of trackage being the cause of much of the agitation produced, the speed of the vessel might be considerably increased, if the propelling force were carried on board of the boat.

DESCRIPTION

OF AN

APPARATUS FOR BORING OR SINKING PITS IN QUICKSANDS, &c.

(Plate VI.)

By Mr John Busby, Mineral Surveyor.

Having had the honour to exhibit in actual operation at Leith Sands, before the Right Honourable Sir John Sinclair, Baronet, Mr Gordon, Secretary to the Highland Society, Messrs Stevenson, Bald, and Jardine, engineers, and other gentlemen of the Highland Society, the instruments employed by me in sinking and boring through quicksands, gravel, &c., and having been solicited by these gentlemen to lay them before the Society and the public, I now beg leave to give a description of the instruments I have improved, and of the additional instruments I have long been in the habit of using; noticing at the same time the methods I adopt in the use and management of them.

The common sludger, represented at Pl. VI. Fig. 1., is made of hammered iron; is from two to

three feet in length, including the screw and neck, and of a degree of strength altogether unnecessary. Its capacity is extremely small, owing chiefly to its shortness, but in some measure also to the thickness of the metal. Its valve is made partly of iron, and partly of leather, and works upon an iron hinge. The instrument which I have long used, represented by Fig. 2. Pl. VI. is made of plate-iron, and is from 5 to 6 feet in length. The screw *a*, is fixed into the upper end by means of lead, and the other or lower end *b*, is furnished with a leathern valve, which is fixed by a wire passing through two small holes in the leather, and two corresponding holes in the side of the tube. The contents are discharged by an opening in the side of the instrument, towards the top, as at *c*.

On a comparison of the two instruments, it will be obvious that the capacity of the new is three or four times greater than that of the old, and that its efficiency will also be greater in the same proportion. In a deep bore-hole, therefore, the saving of time effected by the employment of my instrument, is of itself a weighty consideration. But, in boring through the running metals, the advantages arising from it are still more striking. In bore-holes passing through such loose materials, the continual friction of the roads throws down large quantities of stuff; and this gradually accumulating at the bottom of the hole, impedes the working of the tools, and requires the frequent introduction of the sludger for its removal. In many instances, much

more time is spent in clearing out the bore-hole than in increasing its depth, and I have often known the bore-hole altogether abandoned, from no other cause than the inefficiency of the common sludger. The construction of the valve I consider a very essential improvement. In whatever way the instrument is made, the valve is going wrong almost hourly. When it and its hinge are made of iron, it must be sent to the blacksmith to be repaired, and the work, however important, must, for the time, be stopped. In my instrument, the valve can be taken out and be replaced, in a few minutes, by the operator himself. Figs. 1. and 2. Pl. VI., represent the new and old sludgers.

Fig. 3. in Pl. VI. exhibits a section of two lengths of the metal-pipes I use in boring through quicksands. Each of them is 3 feet in length, and measures 2½ inches in the diameter of the bore. In operating, one of these, *aa*, is inserted into the bore-hole; the sand is withdrawn from it by means of the pump or sludger Fig. 2., and the pipe gradually descends by its own weight, or is occasionally aided by a little pressure. A second pipe, *bb*, is then inserted into the upper extremity of the first, as is shewn in the drawing; a third can be added to the second; and so on successively, till the lowest reaches some way into solid or compact matter. In this manner a continuous tube is formed, through which the bore-hole may be continued downwards to any depth. In many cases we meet with alternate beds of sand and clay, and the pipes have then to be sent through

both. Fig. 4. is an instrument for facilitating their descent through the clay.

The common rods and tools, aided by the improved sludger, and the pipes above described, are of the greatest utility in many branches of engineering. By discovering accurately the depth of sand and gravel-beds, and the nature of the subsoil, they enable the engineer to make an accurate estimate in many cases, where, without such means, this would be impossible. This apparatus may be employed with the greatest advantage in making surveys for canals, in ascertaining foundations for bridges, docks, piers, &c., in boring for coal, and in every case where the progress of the work is interrupted by quicksands or gravel.

With regard to sinking through quicksand, the general practice has been, to lift both the sand and water out of the excavated pit, and to support the sides by cylinders of metal or wood, which descend by their own weight, as the excavated matters are withdrawn: the contiguous quicksand being pressed by the incumbent weight, speedily fills up the space again; and the surrounding ground, to the distance, perhaps, of many feet, gradually sinks. The workmen are unable to gain upon the sand, thus constantly pouring in upon them from beneath the cylinder, and the work remains stationary. In one instance, in which many attempts to descend below the depth of six feet had proved unsuccessful, it occurred to me, that if I could dig without removing the water, its pressure from within would counteract

that of the sand from without, and prevent the latter from running. In this view I was not mistaken, and, after contriving a suitable apparatus, I succeeded beyond my most sanguine expectations, in digging to the required depth of 24 feet.

Pl. VI. Fig. 5. represents an instrument for digging through sand and gravel under the circumstances above described. It is made of strong plate-iron, and bears some resemblance to a common coal-scuttle; *a b* is an iron rod, passing through the end, and fixed there, and, for greater strength, it is also fixed at *b*, in the lower side of the instrument; *d* is a small chain attached to *a b*, and having a hook, by which it is fixed to the rod immediately above. The machine has also a handle *cc* fixed to its sides near the open end. When it is intended for use, the instrument is screwed loosely to the rods, and the chain hooked. It is then lowered down, when the weight of the rods, on a slight degree of pressure, will be sufficient for its mouth *f*, fig. 8. to penetrate the sand or gravel. The water in the upper part of this iron basket is allowed to escape by two or three small perforations. When it has been pressed into the sand to a sufficient depth, the joint at *a* is unscrewed; the rods, which are still attached by the chain, are pressed backwards and also downwards, and the upper end, or mouth, is turned up by the rope attached to the handle. Both the rods and basket are now drawn up, the chain unhooked, and the contents discharged.

This instrument is well calculated for deepening or digging foundations in quicksands, or other soft materials under water, where the expence and confined situation render the application of the dredging-machine inadmissible. On shoals of sand-banks where beacons or sea-marks for the mariner are required, this mode may be employed for sinking cylinders for the purpose of supporting columns. And on one or more of these columns a beacon, bell, or even a lighthouse, might be erected.

Pl. VI. Fig. 6. By removing the valve from the sludger, and inserting a tin-tube, such as is represented in this figure, having an opening through its whole length, we have an instrument by which a complete bore or section of the matters passed through may be exhibited. The tin-tube is furnished at its upper end with a valve, to prevent the contents from falling out when it is drawn up, and a ring is inserted into the lower end to retain the tube in its situation within the sludger. This instrument is highly useful in agriculture for passing through moss and marl, being chiefly applicable where the materials to be passed through are soft.

Pl. VI. Fig. 7. is a representation of the apparatus required for lowering and raising the basket Fig. 5.; and Fig. 8. exhibits the different stages of its progress: *a* is the basket, when in the act of being pushed into the sand by the weight of the rods *b c*, or by pressure applied at the top; *d* is the basket, now supposed to be filled, and the rods *b c* unscrew-

ed from the handle a; the mouth of the basket being now in the act of rising upwards, by the power applied to the rope $e\,e$, worked by the winch-machine in Fig. 7. f, Fig. 8. represents the basket charged with sand and gravel, and new raised, shewing the position in which it is drawn up, together with the rods, to discharge water after each operation.

DESCRIPTION

OF AN

INSTRUMENT,

FOR ASCERTAINING THE COMPOSITION, THICKNESS, &c. OF STRATA AT ANY PARTICULAR DEPTH.

(*Plate VI. Fig.* 9, 10, 11.)

By Mr JOHN BUSBY, Mineral Surveyor.

Circumstance which led to the Invention.

IT having been reported to the Marquis of Queensberry, by persons employed by him in boring for coal on his estate at Killhead, that, at the depth of 157 feet, they had passed through a seam of coal, 11 inches in thickness; and circumstances having excited suspicion as to the correctness of this report, his Lordship employed me to examine the bore-hole.

Its applicability proved.

The instrument I employed, was that immediately to be described, which was found to answer the

highest expectations that had been formed of it. My examination determined unequivocally the point at issue; having found, that, at the depth stated, instead of coal, there was nothing but freestone; and that, for many feet both above and below that depth, no indications of coal presented themselves.

Description.

The instrument consists of a bar of iron, A A, fig. 9. Plate VI., of considerable strength, about $2\frac{1}{2}$ feet long, armed at one extremity with a screw, by which it is attached to the boring rods, and at the other with an iron-cup, B. (See enlarged representation, fig. 11.) About the middle, or towards the higher end, there is a longitudinal fissure or opening, about 6 inches in length, and three-fourths of an inch in width, into which are fitted two blades C C of a somewhat triangular form. (See fig. 10.). The upper ends or roots of these blades are connected to the bar of iron within the opening, by a strong iron pin, around which they have a certain degree of motion. To the back of each blade, *a a* fig. 10. is attached a strong spring, by which, when the instrument is free from lateral pressure, the blades are kept extended; and by the action of which, when subjected to such pressure, they have a constant tendency to press outwards, or to extend themselves; their lower ends or points being, at the same time, restrained from passing too far out, by a notch in the opening.

Mode of Operation.

Its mode of operation is this. After it has been screwed to the rods, it is introduced into the borehole, the sides of which compress the blades, and retain them within the fissure. By the application of pressure upon the rods from above, the instrument is made to descend to the depth required. It is then simply turned; and the blades, by their tendency to expand, are forced into the sides of the borehole, breaking off small fragments of clay, sandstone, coal, &c.; and these falling, are received by the cup attached to the lower end of the instrument. The instrument is then drawn up, and the contents of the cup examined.

Uses.

In its uses, this instrument is not limited to the mere discovery of the materials of which any strata may be composed. It will also be found to register, with great accuracy, either in its descent or ascent, their thickness. It will be of great utility to engineers and contractors: to the former, in assisting them to prepare the specifications of the cutting in canals; and to the latter, in enabling them to satisfy themselves of the accuracy of these specifications; a few minutes only being required for a trial. But its value will be more easily estimated, when it is considered, that the operation of boring

is practised by men, who, in general, are unable to give any satisfactory account of their work, and who, to protract their employment, would give any account, rather than an unfavourable one, as in the instance above alluded to. By means of this instrument, in doubtful cases, gentlemen may at once inform themselves on any point, by causing their men to use it in their presence. It will, therefore, operate as a constant check upon the workmen; supersede even the necessity of an overseer, and prevent many of those frauds which are daily practised, and which have hitherto escaped the possibility of detection.

JOHN BUSBY.

EDINBURGH,
21*st Feb.* 1822.

DESCRIPTION

OF A

MILK CHURN

WORKED BY THE IMPULSE OF WIND UPON SAILS.

(Plate VII. Figs. 7. & 8.)

By Mr GEORGE FIRTH of Sanday, in Orkney.

Island of Sandday, Orkney,
SIR, *Bayfield House, 9th Nov. 1822.*

IN reference to a conversation that passed betwixt us when I had the honour of seeing you in Sanday, I have now taken the liberty of sending, by the Orkney packet, in a box, addressed to you, a model of the Churn which I invented about four years ago, and which you and Mr Stevenson examined, in order that you may present it to the Highland Society, with the view of getting me a premium, provided the Society should think my exertions, or the machine itself, merits it. It does not, perhaps, become me to speak in praise of this machine, invented entirely by myself; but I can with confidence assure you, that, since its invention, its utility, in the saving of labour, has made it to be almost universally used in this quarter of the country; in proof of which, I inclose, for your perusal, a few certificates * which I received from

* These certificates are very satisfactory, though it is not thought necessary to insert them.—*Ed.*

some of the most respectable residenters and landholders in the county. Not only does the machine produce butter of superior quality to what was made in the ordinary way practised in Orkney, but, from the steady operation of the machinery, it produces more in quantity.

From the simple construction of the churn, it requires little or no description; and I shall only mention, that the wheel, and iron-plate in which it moves, (A, fig. 7. and 8. Plate VII.), as will easily be perceived, are for the purpose of increasing the velocity of the breakers inside the churn, (see *b b b b* fig. 7.), when worked by the winch, which must be the case when there is no wind. By unscrewing the four nuts marked 1, 2, 3, 4, fig. 8., the iron-plate and wheel can be easily taken from the churn, which is necessary to be done when it works with the wind; but if the person who attends the dairy is attentive, there will be little or no use for the winch. When the plate and wheel are taken off, put on the iron, for supporting the sails, *a a a a* fig. 8., made in form of a cross, on the end of the axle, which turns round the breakers, and screw on the nut marked B, fig. 8. to keep the cross-iron free from shaking; then put the arms of the sails in the proper places made for them, on each leg of the cross-iron, as marked C D E F, fig. 8., and put in the pins fastened to each arm, to prevent the sails from falling out of their proper places; then place the churn on a square frame, made with four posts, high enough to prevent the ends of the sails from touching the ground; put a piece of

board across, at the bottom of the frame, on which a sufficient weight can be laid, to prevent it from blowing over. The churn is fastened to the frame with a hook, at each end, such as are fastened to the model. The motion can be regulated according to the strength of the wind, at the time of churning, by reefing the sails, the operation of which is so plain, as to need no description; if it blow very strong, the churn will work with two reefed sails; the time it takes in churning varies, according to the strength of the wind, and also whether the weather be cold or hot, as it takes a considerable time longer to churn, in the former case, than in the latter.

In the churn which you saw in Sanday I commonly churn from 15 to 16 wine gallons at a time, which, in summer, with a smart breeze, takes about two hours; but when the wind is moderate, or the weather cold, it requires a longer time. A little while before the milk is completely churned, it is necessary to reef the sails, as the motion of the breakers should not be so rapid as at the beginning. Indeed, it requires no other management than a common churn, once it is set to work, except reefing the sails, if it blow too much, which a day or two's practice would sufficiently instruct even a girl of 12 or 14 years of age to manage. When the milk is completely churned, the sails must be taken from their places, and the top of the churn taken off; then let the top of the breakers be held with the left hand, and, by taking hold of the cross iron with the right, unscrew the axle out of the breakers; then let them

out of the churn, to prevent any inconvenience in taking off the butter.

When I state that the model was made by myself, without the assistance of tools necessary for the purpose, I trust it will be a sufficient excuse for the rough and clumsy manner in which it is finished. I remain respectfully, Sir, your most obedient servant,

GEORGE FIRTH.

Dimensions of the churn which I first made, and have used ever since.

Length of churn inside,	-	23	inches.
Width, do.	-	14	do.
Depth, exclusive of the top,		19	do.
Depth of top, do.	-	$4\frac{1}{2}$	do.

Dimensions of sails for said churn.

Length of sail,	- -	27	do.
Breadth, do.	-	20	do.

Each arm of the cross iron, 7 inches long.

To CHARLES GORDON, Esq.
Dep. Sec. Highland Society.

DESCRIPTION

OF A

STOVE,

Presented by the Earl of Elgin to the Highland Society.

(Plate VII., Fig. 9.)

Edinburgh,
January 8. 1822.

THE Stove, of which Lord Elgin presented a model to-day to the Highland Society, as being a most economical and advantageous application of fuel, is in general use in the Netherlands. Any person visiting the field of battle of Waterloo will find one in the house of the *Belle Alliance*.

It consists of a small fire-place in the shape of a basket A, fig. 9. Plate VII., with open ribs all around, of about eight inches in diameter and depth, supported by three legs, and stan[illegible] at some distance from the chimney. From the top of this fire-place, an horizontal flue *a a*, of about twelve inches wide,

and two inches depth within, extends to the chimney, to which the smoke passes through this horizontal flue.

The benefits of this application of fuel appear to be:

1*st*, That the fire-place by standing clear, and having ribs all around, will burn the smallest coal; or indeed whatever is combustible. Lord Elgin has seen it used at an Inn at Louvain with nothing in it but the ashes from another fire.

2*d*, The horizontal flue, which in general is about four feet in length, gives out a great proportion of the heat, which in ordinary fire-places escapes up the chimney.

In this flue immediately above the fire, there is an opening, which may either be kept shut by a lid *b*, or receive a boiler; and the flue in all its length, serves as a Carron plate, not only to the extent of its own width, but by means of side-bars *c c*, dishes, &c. may be kept in a more moderate heat, than directly upon the flue itself; while by other bars or shelves below it *d*, ovens or other dishes placed beneath it, receive more or less heat, in proportion as they are brought near to the fire-place.

In some cases the whole space beneath the fire is enclosed with bricks, forming a very convenient hot closet.

Where peat is used, it may be proper to substitute an ordinary grate with only one open front, instead of the basket fire-place, thereby mode-

rating the combustion to suit the nature of that fuel.

This stove really seems to answer all the purposes of an ordinary stove, in respect to the economy of heat, while it has the great advantage and comfort of an ordinary open fire.

N. B.—In the model presented, the fire-place is out of proportion.

DESCRIPTION

OF A

MACHINE FOR SWEEPING CHIMNEYS.

By Mr James White, Engineer.

(Plate VII., Fig. 10, 11.)

Edinburgh, 138. *George Street*,
23d February 1822.

Sir,

Permit me the liberty of troubling you with a short history of my machine for sweeping chimneys, which I lately presented a model of, directed to you, for the Highland Society of Scotland.

In 1817, the London practice of sweeping chimneys by boys was expected to be abolished by a bill then about to be brought into the Commons House of Parliament. It was at that time my machine was invented, with a view to supersede the necessity of their employment.

The principles of my invention are simple. The mode of ascending of the machine is very similar to that of a boy, having levers for arms, as seen at *a a* fig. 11. Plate VII., and the friction of a brush for legs, *b b*. Two lines belong to the machine *c c*. By an action in the first, the levers *a a* open, and

become fast in the chimney; and, at the same time that line is pulled, the brush A rises in proportion to the pull made, see fig. 10. The next process is to act on the second line. That being done, the levers *a a* are loosened in the chimney, and are made to rise on the friction of the brush, in proportion to the length of the whale-bone-rod which connects the levers and brush together; in the same manner as a boy relieves his knees and elbows alternately till he reaches the top of the chimney.

Having said a little descriptive of its mode of ascending, I shall now endeavour to explain how it comes down. When the second line is pulled for that purpose, the lower end of the rod is so contrived that, when it comes against the bottom of the brush, which it passes through, the levers become shut. Nothing remains then, but to overcome the friction of the brush, which may be done by continuing the same pull, until the apparatus is brought down. It is ascertained that the machine is at the top of the chimney, when the levers have nothing to become fast to; for that line which opens them, and raises the brush on the rod, immediately becomes slack, which had not been the case during the whole process of its ascent.

Having endeavoured to describe the principles of my machine in a brief way, I understand it is necessary, for the information of the Society, to mention what success my experiments have met with, previous to the time of submitting it to their consideration. In 1817, I presented my design to the So-

ciety of Arts, Adelphi, London. It passed the Committee for Mechanics, which was then composed of the principal engineers in London, with a reward of Thirty Guineas or a Gold Medal. That vote being afterwards submitted to a General Meeting of the Society, was remitted to the committee for their farther consideration. I felt on that occasion as any other would have done at such treatment, and withdrew my design from the Society the following day. Shortly after this circumstance happened, Mr Bramah, engineer, Pimlico, gave me a recommendation to the present Lord Gwyder, who was then much interested in promoting the use of machinery for sweeping chimneys, in order to abolish the cruelty of sweeping-boys. His Lordship, with that generosity so seldom to be met with, came forward as patron for the design, and covered, with pleasure, the expence of my after experiments, which had various degrees of success, according to the construction of the chimneys in which the machine was employed, and the knowledge of those who directed its operations.

In 1818, when at Drummond Castle, I received a letter, dated from the Office of Works, London, requesting me to send them a model or drawing of my invention for sweeping chimneys, which I complied with. For the use they have made of it, I will refer you to the report of the Committee appointed by the House of Commons on that subject, of which you are in possession. Having afterwards more leisure, I improved it at Drummond Castle,

so as to ascend a flue, with a right angle, the corner rounding.

I have now, Sir, to return you my warmest thanks for the attention you have paid me since I first delivered to you the charge of my design. Knowing the Highland Society is not in the practice of rewarding inventions in general, except they bear, in some measure, on agricultural improvements, I cannot feel disappointed if the result of my labours should meet with no other remuneration than that of being received into the Society's repository among the various inventions of my countrymen. I have the honour to be, Sir, your most obedient and very humble servant,

JAS. WHITE.

To CHARLES GORDON, Esq. Depute Secretary of the Highland Society of Scotland.

GENERAL APPENDIX.

GENERAL APPENDIX.

No. I.

List *of* Existing Members *of* The Highland Society of Scotland, *in January* 1824; *distinguishing the Dates of their Admission;*

WITH A

LIST OF THE OFFICE-BEARERS AND DIRECTORS FOR THAT YEAR ANNEXED.

The late Duke of Argyle was the original President of the Society.—Since his death, the Dukes of Atholl and Montrose, the late Duke of Buccleuch, and the present Duke of Argyle, have successively held that Office, which is now filled by the Duke of Gordon. By the Regulations, no Member can continue in the office of President more than four consecutive years. Those marked thus ** have been Presidents; and those with * prefixed to their names have been Vice-Presidents; two of whom are elected annually, in place of two who go out by rotation.

The following were declared Original Constituent Members of the Society in 1784.

The Right Hon. Elizabeth, Marchioness of Stafford, and Countess of Sutherland
* The Right Hon. John, Earl of Breadalbane
* The Right Hon. George, Earl of Glasgow
* The Right Hon. Sir John Sinclair of Ulbster, Bart.
The Honourable Lord Eldin
Sir William Honyman of Armadale, Bart.
Sir William Macleod Bannatyne
Sir Alexander Muir Mackenzie of Delvin, Bart.
Sir Benjamin Dunbar of Hemprigs, Bart.
Sir Ewen Cameron of Fassfern, Bart.
Donald Macleod, Esq. of Geanies, Sheriff of Ross-shire
James Grant, Esq. of Corymony, Advocate

General Alexander Campbell of Monzie
Lieutenant-General Duncan Campbell of Lochnell
Archibald Fletcher, Esq. Advocate
James Ferrier, Esq. one of the Principal Clerks of Session
John Campbell, Esq. Clerk to the Signet
Charles Gordon, Esq. of Pulrossie
Patrick Macdougall, Esq. of Macdougall
Henry Mackenzie, Esq. Comptroller of Taxes
James Horne, Esq. of Langwell
General Alexander Ross, Colonel of the 59th Regiment
William Farquharson, Esq. of Monaltry
William Macfarlane, Esq. W. S.

Elected in 1785.

** His Grace James Duke of Montrose
The Hon. Lord Hermand
Alexander Maclean esq. of Coll

10*th January* 1786.

George Skene esq. of Skene

24*th July* 1786.

** His Grace Alexander Duke of Gordon
Eneas Robert Bruce Macleod esq. of Cadboll

9*th January* 1787.

Sir John Leslie of Findrassie and Wardes, Baronet
John Francis Erskine esq. of Mar
John Campbell esq. W. S. now of London

27*th July* 1787.

Most Noble George Marquis of Stafford
* Right Hon. James Earl of Rosslyn
Sir John Campbell of Ardnamurchan, Baronet
Alex. Hamilton esq. of Grange, advocate

8*th January* 1788.

Sir George Stewart of Grandtully, Baronet
The Hon. Lord Robertson

25*th July* 1788.

Lieut.-Col. Thomas Kinloch of Kilrie

13*th January* 1789.

Arch. Campbell esq. of Jura
Major-General Robert Campbell of Kintarbert
Norman Macdonald esq. of Barnisdale
Alex. Macalister esq. of Strathaird
Lieut.-Col. Alex. Macdonald of Lyndale

1*st August* 1789.

** His Grace John Duke of Atholl
The Right Hon. James Earl of Lauderdale
Major Colin Campbell of Balliveolan
William Kerr esq. late Secretary, General Post Office of Scotland

12*th January* 1790.

** His Grace George William Duke of Argyle

Coll Macdonald esq. of Dalness, W. S.

Lieut.-Col. James Spens, late of the 73d Regiment

Hector Macdonald Buchanan esq. of Drumakill, one of the Principal Clerks of Session

11th January 1791.

The Hon. Lord Craigie

James Lamont esq. of Knockdow

John Macleod esq. of Colbecks

8th July 1791.

* The Most Noble George Marquis of Huntly

Major-Gen. Sir Allan Cameron, 79th Regiment.

10th January 1792.

Right Hon. Sir William Drummond of Logie-Almond

John Peter Grant esq. of Rothiemurchus, M. P.

The Hon. Lord Succoth

29th June 1792.

David Macdowall Grant esq. of Arndilly

Colin Mackenzie esq. of Portmore, one of the Principal Clerks of Session

8th January 1793.

* The Right Hon. Francis, Earl of Moray

* Right Hon. Francis, Lord Gray

Right Hon. Charles Hope, Lord President of the Court of Session

Hon. Baron Sir P. Murray of Ochtertyre, Baronet

Col. Donald Cameron of Lochiel

Alex. Macdonell esq. of Glengary

James Grant esq. W. S.

Alex. Maclean esq. of Ardgour

Alexander Houston esq. of Clerkington

George Watson esq. Edinburgh

Donald Maclean esq. W. S.

Captain Alexander Macdonald, late 74th Regiment

The very Rev. Dr Geo. H. Baird, Principal of the University of Edinburgh, Chaplain to the Society

Sir Robert Dundas of Beechwood, Baronet, one of the Principal Clerks of Session

1st June 1793.

* The Right Hon. Archibald Earl of Cassilis

* Right Hon. Francis Earl of Wemyss and March

* Right Hon. George Earl of Aboyne

Sir John Hay of Haystoun, Baronet, banker, Edinburgh

Thomas Farquharson esq. of Howden

Dr Andrew Coventry, Professor of Agriculture in the University of Edinburgh

Dougald Campbell esq. of Balinaby

John Campbell esq. of Carbrook, W. S.

14th January 1794.

Sir Archibald Dunbar of Northfield, Baronet

John Leslie esq. of Balquhaine

Patrick Murray esq. of Simprim

William Inglis esq. of Middleton

James Laidlaw esq. W. S.

29th June 1794.

Charles Stewart esq. of Ardsheal

13th January 1795.

James Dewar esq. of Vogrie

Walter Watson esq. late of Bombay
John M'Ritchie esq of Craigton

22d June 1795.

James Mansfield esq. of Midmar
Alexander Watson esq. of Turin
Captain Neil Campbell of Dunstaffnage
Thomas Crichton esq. advocate

13th January 1796.

* The Right Hon. Alexander Lord Macdonald
Major-General the Hon. Godfrey Bosville
Hon. Archibald Macdonald
Sir George Abercromby of Birkenbog and Forglen, Baronet
James Stirling esq. of Keir
Hope Stewart esq. of Ballechin
John M'Neil esq. of Oakfield
Cap. Alex. Macleod of Dalvey
Archibald Lundie esq. W. S.
John Ferrier esq. W. S.
James Donaldson esq. Edinburgh

4th July 1796.

Rt. Hon. Thomas, Earl of Kellie
Sir James Hall of Dunglass, Baronet
R. Macdonald esq. of Staffa, advocate, Principal Secretary of the Society
James Raymond Johnston esq. of Alva
Major Charles Macvicar, late of the 42d Regiment
William C. Cunningham Graham esq. of Gartmore
Lieut.-Gen. Alexander Dirom of Mountannan
George Greenlaw esq. of Hilton
John Young esq. of Cliesh
Lieut.-Col. Charles M'Quarrie, late of the 42d Regiment

10th January 1797.

James Traill esq. of Hobbister, Sheriff of Caithness
Col. Matt. Macalister of Rosshill
Archibald Alves esq. of Springfield.
Lieut.-Col. James Campbell 94th Regiment
Captain John Robertson of Tullybelton
William Elder esq. of Forneath

3d July 1797.

Sir Hew Dalrymple Hamilton of Bargeny and North Berwick, Bart. M. P.
Cap. John Macdonald of Springfield
John Ochterlony esq. of Guynd
John K. Campbell esq. of Glenfeochan, W. S.
Lieut.-Col. John M'Donald of Kingsburgh

9th January 1798.

The Right Hon. Lord John Campbell
Captain Angus M'Donald of Miltown
Major Alexander Grant of the Madras Cavalry
James Gordon esq. of Culvenan, one of the Commissaries of Edinburgh
James Edmonston esq. of Newton
Lt.-Col. James Sinclair of Forse
Robert Menzies esq. W. S. one of the Depute-Clerks of Session

2d July 1798.

* Right Hon. Robert, Lord Visc. Melville, First Lord of the Admiralty
Sir James Dalyell of Binns, Bart.
James Macleod esq. of Rasay

Robert Nutter Campbell esq. of Kailzie
Robert Drummond esq. of Megginch
Gen. Ilay Ferrier, Lt.-Governor of Dumbarton Castle
Theodore Morison esq. of Bognie
Henry Johnston esq. Surgeon, Edinburgh
Alex. Forsyth esq. writer, Edin.
Andrew Watson esq. W. S.
Captain Iver M'Millan of the Valentine Indiaman
Thos. Smith esq. banker, Lond.

8th January 1799.

* Most Noble Charles Marquis of Queensberry
* The Right Hon. George Earl of Morton
The Right Hon. George Lord Abercromby
Sir Michael Schaw Stewart of Greenock and Blackhall, Bart.
Colonel Robert Anstruther, Edinburgh
Gilbert Innes esq. of Stow, Treasurer of the Society
Hugh Monro esq. of Teaninich
Murdoch Mackenzie esq. of Ardross
John Mackenzie, esq. of Kincraig
Wm. Stewart esq. of Ardvorlich
Cap. Dugald Stewart of Balachulish
Dr James Home, Professor of Medicine in the University of Edinburgh.
David Monro Binning esq. of Softlaw
*Captain Patrick Campbell of Inveraw
Sir Adam Ferguson, Knight
Captain Neil Macleod of Gesto

1st July 1799.

The Hon. Robert Lindsay of Leuchars.
Geo. Oswald esq. of Scotstown
Lt.-Col. Ro. Macgregor Murray
John Smith esq. of Swinridgemuir
James Pillans esq. merchant, Leith
Henry Jardine Esq. of Harwood, King's Remembrancer in Exchequer
Alexander Campbell esq. late of Tobago
John Osborne Brown esq. W. S. one of the Clerks of the Jury Court
Lewis Gordon esq. Depute Secretary of the Society
Thomas Martin esq. Edinburgh
John Tawse esq. Edinburgh
Archibald Menzies esq.

14th January 1800.

* The Right Hon. Charles Earl of Haddington
General Sir Robert Abercromby of Airthry, G. C. B.
General Sir James Stewart Denham of Coltness and Westshields, Baronet
Hon. Lord Meadowbank
John Campbell esq. of Lincoln's Inn
Alexander Marjoribanks esq. of Marjoribanks
Al. Macleod esq. of Muiravonside
Simon Fraser Esq. of Foyers
William Pagan esq. of Spittaltown
Craufurd Tait esq. of Harviestoun
George Tod esq. writer, Edin.
Major Patrick Macdougall of Scroba
Major Alex. M'Ivor of Stornaway
James Chapman esq.

James Shearer esq. Surveyor-General Post-Office, Edin.
Pat. Stewart esq. of Achluncart
George Douglas esq. advocate, Sheriff of Kincardineshire
Donald Macleod esq. of Talisker
Thomas Grierson esq. W. S

30th June 1800.

Right Hon. Erick Lord Reay
Right Hon. Lawrence Lord Dundas
Hon. Lord Balgray
Sir James Gordon of Letterfourie, Bart.
George Baillie esq. of Jarviswood
William Nisbet esq. of Dirleton
Arch. Campbell esq. of Blythswood
Hercules Ross esq. of Rossie
Lewis Dunbar Brodie esq. of Burgie
Archibald Swinton esq. W. S.
John Dillon esq. Sheriff-substitute of Lanarkshire
Duncan Cameron esq. younger of Fassfern, W. S.
And. Farquharson esq. of Breda
Thomas Williamson esq. Leith
John Gillanders esq. of Hayfield
James Herriot esq. of Ramornie, W. S.
James Walker esq. wine merchant, Leith
Robert Hill esq. of Firth, W. S.
James Ferguson esq. of Crosshill, one of the Commissaries of Edinburgh
William Berry esq. of Tayfield, W. S.
Charles Brenner esq. W. S.

13th January 1801.

Right Hon. Lord Montague
Sir G. S. Mackenzie of Coul, Baronet
Sir David Hunter Blair of Dunskey, Bart.
Sir James Colquhoun of Luss, Bart
Sir William Fettes of Wamphrey, Bart.
Lieut.-Gen. A. Graham Stirling of Duchray and Auchyle
William Grant esq. of Congalton
Colonel James Campbell late of Madras
Col. Lud. Grant, late of Bengal
Major-General John Lamont of Lamont
Col. Alex. Murray Macgregor of the late Ceylon Regiment
William Fullerton esq. of Skeldon, advocate
George Bruce esq. Depute Clerk of Session
William Mackenzie esq. younger of Pitlundie
Lieut.-Col. Alexander Gordon, Sutherland Highlanders
Alex. Paterson esq. of Thurso

29th June 1801.

Right Hon. Will. Dundas, M. P.
Sir William Bruce of Stenhouse, Bart.
Sir James Montgomerie of Stanhope, Bart. M. P.
Col. John Boyle of Shewalton
Lieut.-General Andrew Dunlop of Dunlop
Major-General Sir Thomas Brisbane of Brisbane
Col. Andrew Macdowal of Logan
Alexander Stewart esq. younger of Balnakeilly
John Stewart esq. of Crossmount
Hugh Mair esq. of Wisgby
Wm. Graham esq. of Mossknows
John Murray esq. of Tundergarth
William Stewart esq. of Hillside
Colin Mackenzie esq. of Kilcoy

Robert Patrick esq. of Treehorn
James Smith esq. merch. Leith
William Ker esq. merchant, Leith
Adam White esq. merch. Leith
Mr John Moir, printer, Edin.
Alexander Lang esq. younger of Overtown
Right Hon. Lord Bexley, *Honorary Member*

12th January 1802.

Right Hon. Sir William Rae of St Catherine's, Lord Advocate for Scotland
Sir Henry Stewart of Allanton, Bart.
William Fullerton esq. of Rosemount
James Graham esq. of Kinross
Sir Hugh Innes of Lochalsh, Bart. M. P.
Duncan Monro esq. of Culcairn
Geo. Jos. Bell esq. adv. Professor of the Law of Scotland in the University of Edinburgh
Wm. Fraser Tytler esq. of Balnain, Sheriff of Inverness-shire
John Fraser esq. Faraline, adv.
Dr Andrew Mackenzie Grieve, Edinburgh
Vans Hathorn esq. Garthland, W. S.
Vice-Adm. Alex. Fraser, R. N.
Lieut.-Col. Don. Macniel, 91st Regiment
Cap. Will. Gordon, Minmore
Rob. Gordon esq. Jamaica
Colin Campbell esq. of Achnacroish
Col. Francis Simpson of Plean
Rob. Baillie esq. of Carphine
Major Dugald Campbell of Kilmartin
Arch. M'Lean esq. Pennycross
Robert Brown esq. factor on the estate of Hamilton
Sir James Dunbar of Boath, Baronet, R. N.
James Macpherson esq. of Ardersier
Alexander Mackenzie esq. of Woodside
Arch. M'Ra esq. of Ardintoul
Duncan Campbell esq.
Arch. Campbell esq. of Melford

28th June 1802.

Sir Rt. Turing of Foveran, Bart.
Sir William Forbes of Pitsligo, Bart. banker in Edinburgh
J. H. Forbes esq. advocate, Sheriff of Perthshire
Henry Veitch esq. of Elliock, one of the Commissioners of Customs
Charles Grant esq. of Waternish
Sir Neil Menzies of Menzies, Bt.
Thomas Miller esq. of Glenlee
William Macdonald esq. of St Martins, advocate
John Dickson esq. of Coulter and Kilbucho, advocate
Robert Hamilton esq. advocate, one of the Principal Clerks of Session
Ad. Maitland esq. of Dundrennan
John Callow esq. of Stapleton
Wm. Molle esq. of Mains, W. S.
Duncan Hunter esq. of London
Major-General Arch. Stewart of the Royals
John Gordon esq. W. S.
Robert Fraser esq. of Torbreck.
Walter Ross esq. of Nigg
Captain John Rutherford of the 35th Regiment
Hugh Hamilton esq. of Pinmore
Rob. Campbell esq. of Sonachan

12th January 1803.

* Right Hon. William Earl of Mansfield
Honourable Dudley Macdonald
General Richard Vyse

Colonel, The Hon. Francis William Grant of Grant, M. P.
Major-Gen. George Ainslie
Jas. Douglas esq. of Orchardton
William Gordon esq. of Campbeltown
Peter Johnston esq. of Cairnsalloch
John Clerk esq. of Nunland
David Macculloch esq. of Leaths
Charles Granville Stewart Menteith esq. of Closeburn
General Sir Paulus Emilius Irvine of Woodhouse, Bart.
Lieut.-Col. William Douglas, late of the 85th Regiment
Richard Alexander Oswald esq. of Auchineruive
Charles Stirling of Kenmore
The Rev. Dr George Forbes, minister of Strathdon
George Kinnear esq. banker in Edinburgh
Robert Jamieson esq. W. S.
Alexander Miller esq. of Monkcastle, advocate
Hon. Lord Mackenzie
William Boswell esq. Sheriff of Berwickshire
John Campbell esq. late of Lochend
Allan Cameron esq. factor for Lord Macdonald, North Uist
John Campbell esq. of Craignure
Lachlan M'Kinnon esq. of Corrie
Peter Hill esq. bookseller, Edin.
Patrick Warner esq. of Ardier
Col. James Macdonell of the 2d or Coldstream Regiment of Guards, C. B.
Duncan Stewart esq. of Glenbuckie, Chamberlain of Kintyre
James Maxwell esq. Chamberlain of Mull
Malcolm M'Laurin esq. of Oban
Robert Campbell esq. Chamberlain of Roseneath
Walter Moir esq. Sheriff substitute of Hamilton

27th June 1803.

* Right Hon. Thomas, Viscount Arbuthnot
Lieut.-Gen. Right Hon. Thomas Lord Lynedock, G. C. B.
Hon. Douglas Gordon Halyburton of Piteur
Sir John Shaw Maxwell of Kerochtrie and Netherlaw, Bart.
Major-Gen. Sir William Maxwell of Monreith, Bart.
James Alexander Stewart Mackenzie esq. of Seaforth
John Cathcart esq. of Genoch
Colonel James Stevenson Barns of Kirkhill
Sir Patrick Walker of Coats, Knight
David Snodgrass Buchanan esq. of Blantyre Park
Jos. Stewart Menzies esq. of Foss
Donald Macintyre esq.
Archibald Crawfuird esq. W. S.
John Campbell esq. of Auch
Cap. John Campbell of Kilmartin, late 46th Regiment
Hugh M'Corquodale esq. of Liverpool
Rev. Dr James Hall, Edinburgh
Arch. Constable esq. bookseller, Edinburgh
William Ross esq. of Bridgebank
James Bell esq. Leith
John Mackenzie esq. Richmond Place
William Mackenzie esq. W. S.

10th January 1804.

* His Grace Alexander, Duke of Hamilton and Brandon
† Most Noble Francis Rawdon, Marquis of Hastings

* Lieut.-Gen. Right Hon. George Earl of Dalhousie, Governor-General of Canada
* Right Hon. James, Lord Glenlyon
Right Hon. Thomas, Lord Binning
Right Hon. David Boyle, Lord Justice-Clerk
Sir George Warrender of Lochend, Bart. M. P.
General Sir George Don, Lieut.-Governor of Gibraltar
Major-Gen. Sir William Keir
Hugh Rose esq. of Kilravock
Honourable Lord Pitmilly
Hugh Mossman esq. of Achtyfardle
John Hamilton esq. of Sundrum
George Paterson esq. of Castlehuntly
Thomas Hamilton Miller, esq. advocate
John Macdonald, esq. of Borrodale
Peter Campbell, esq. of Kilmory
Richard Lothian Ross, esq. of Staffold
William Hagart, esq. wine merchant, Leith
Neil Malcolm, esq. Poltalloch
Dr Jo. Rogerson, Physician to the Forces, N. B.
Jo. Boyd, esq. Broadmeadows
Dr Thomas Charles Hope, physician, Edinburgh
James Hope, esq. W. S.
Walter Campbell, esq. of Carradale
Major-General Jo. Macleod of Unish, 78th regiment
Colonel Muir of Caldwell

2d July 1804.

Sir William Arbuthnott, Bart.
Gen. Wm. Maxwell of Parkhill
Lieut.-Col. Richard William Howard Vyse
Robert William Duff, esq. of Fetteresso
Peter Spiers, esq. of Culcruich
Lieut.-Col Robert Cameron, late of Madras
Lieut.-Col. Ro. Campbell Hamilton of Millburn and Dalserf
Andrew Murray, esq. of Murrayshall, Sheriff-depute of Aberdeenshire
James Farquhar Gordon, esq. of Locharwoods, W. S.
George Bell, esq. surgeon, Edinburgh
Jas. Campbell, esq. of Dunmore
James Connell, esq.
Francis Short, esq. of Courance
Michael Linning, esq. of Colzium, W. S.
William Macleod, esq. of Luskintyre
William Gordon Macrae, esq.
James Watson, esq. factor to Lord Dundas
John Rae, esq.
John Menzies, esq. cashier to the Duke of Gordon
Joseph Gordon, esq. of Carroll, W. S.
James Mackay, esq. goldsmith in Edinburgh, the Society's jeweller and medallist
William Wilson, esq. factor for the Earl of Glasgow
David Mutrie, esq. merchant in Glasgow

8th January 1805.

The Right Hon. Flora, Marchioness of Hastings and Countess of Loudon
Right Hon. James, Earl of Fife, M. P.
The Hon. William Ramsay Maule of Panmure, M. P.
Sir Andrew Cathcart of Carlton, Bart.

Sir James Ferguson of Kilkerran, Bart.
Sir George Montgomery of Macebiehill, Bart.
Alexander Irvine Forbes, esq. of Chivas, advocate.
Alexander Moir, esq. of Scotstown
John Rogerson, M. D. physician to the Court of St Petersburgh
Major-Gen. Sir Thomas Dallas
Lieut.-Col. Robertson Macdonald of Kinlochmoydart
Kenneth Mackay, esq. of Torboll
Alex. Fraser, esq. of Inchcoulter
Jas. Forrest, esq. of Commieston
Alexander Osborn, esq. one of the Commissioners of Customs
David Ewart, esq. of Craiginvie
John Niven, esq. of Thornton
William Campbell, esq. W. S.
Jas. Cathcart, Esq. merch. Leith
Captain Hugh Stevenson, late of Argyllshire Militia
Alexander Mundell, esq. solicitor, London
William Patrick, esq. W. S.
Robert Rattray, esq. W. S.
Alex. Stewart, esq. of Darculich
James Law, esq. Edinburgh

24th June 1805.

Right Hon. George, Earl of Aberdeen
Sir Alexander Gordon of Culvennan, Knight.
James Macdonald, esq. of Langdale, M. P.
Major-Gen. Lachlan M'Quarrie of Jarvisfield
Major Thomas Hart, late at Ballencrieff
Patrick Small Keir, esq. of Kinmonth, advocate
Richard Wharton Duff, esq. Comptroller of Excise
John Buchanan, esq. of Ardoch, M. P.
Alexander Mackenzie, esq. of Scotsburn
Richard Graham, esq. of Blatewood
Dugald Campbell, esq. of Illandrie
John Gregorson, esq. of Ardtornish
John Ferguson, esq.
Edward Lothian, esq. advocate
John Ker, esq. of Stonypath, W. S.
William Keyden, esq. W. S.
James Scott, esq. of Brotherston
Cosmo Falconer, esq. of Hartwoodhill
Thomas M'Ritchie, esq. merchant, Edinburgh
Andrew Bogle, esq. secretary Royal Bank of Scotland
Gilbert Bertram, esq. merchant, Leith
Wm. Bertram, esq. merch. Leith
Alexander Goalen, esq. Leith

14th January 1806.

His Royal Highness Augustus Frederick, Duke of Sussex
* Right Honourable Archibald John, Earl of Rosebery
Hon. Lord Cringletie
Sir John Hope of Craighall, Bart.
Sir Thomas Gibson Carmichael of Skirling, Bart.
Colonel Elliot Lockhart of Borthwickbrae, M. P.
Robert Stewart, esq. of Fincastle
Lieut.-Colonel George Callander of Craigforth
Lieut.-Colonel Donald Campbell of Knock.
Robert Hepburne, esq. of Clerkington
Wm. Murray, esq of Polmaise
James Hare, esq. of Calderhall
Patrick Miller, esq. Dalswinton
Archibald M'Nab of M'Nab, esq.

Gilbert Young, esq. of Youngfield
Colin M'Lachlan, esq. merchant, Glasgow
Alex. Ramsay, esq. of Demerary
James Fyffe, esq. of Smithfield
John Russel, esq. W. S. one of the Clerks of the Jury Court
Wm. Gilchrist, esq. } merchants,
John White, esq. } Edinburgh
James P. Inglis, esq.
Henry Raeburn, esq. of Stockbridge
Lieut.-Col. James M'Bean, late 78th Regiment.

30*th June* 1806.

Right Hon. Thomas Robert, Earl of Kinnoul
Hon. Charles Douglas
Sir Gilbert Stirling of Rosehall, Bart.
Right Hon. Sir Robert Liston of Listonshiels
John Norman M'Leod, esq. of M'Leod
John Menzies, esq. of Pitfoddels
George Macpherson Grant, esq. of Ballindalloch and Invereshie, M. P.
James Glassford, esq advocate
Jas. Pringle, esq. of Torwoodlee
Gilbert Bethune, esq. of Balfour
Charles S. M'Alister, esq. of Kennox
Gordon Cameron, esq of Letterfindlay
James L'Amy, esq. of Dunkenny, Sheriff of Forfarshire
James Keay, esq. of Snago, advocate
Duncan Macfarlan, esq. advocate
Michie Forbes, esq. of Crimond
Robert Ainslie, esq. W. S.
John Patison, esq. W. S.
Ran. Macdonald, esq. of Borinish
Sir Andrew Halliday, M. D.
James Fowler, esq. of Fortrose, formerly of Jamaica
Major Ludovick Stewart of Java
Captain Alex. Campbell, late of the Scots Greys
Alexander Gillespie, esq. surgeon, Edinburgh
James Gillespie, esq. architect
John Johnston, esq. landsurveyor

13*th January* 1807.

* Gen. Right Hon. William, Earl Cathcart, G. C. B.
Right Hon. Lord Archibald Hamilton, M. P.
Ranald George M'Donald, esq. of Clanranald, M. P.
Lieut.-Gen. Mathew Baillie of Cairnbroe
Colonel John Gordon of Cluny
Roderick Macleod, esq. younger of Cadboll
John Colquhoun, esq. Sheriff of Dunbartonshire
William Douglas, esq. *junior*, of Orchardton
Adam Ferguson, esq. of Woodhill, advocate
Dr Alexander Monro, Professor of Anatomy in the University of Edinburgh
Archibald Graham Campbell, esq. of Shirvan
Ro. Campbell, esq. of Ardchattan
Joseph Williamson, esq. Principal Clerk of Teinds
Alex. Mackenzie, esq. of Hilton
John Gordon, esq. Swinzie
John Brown, esq. of Coultermains
William Grant, esq. of Seabank
Walter Dickson, esq. merchant, Edinburgh
Robert Stevenson, esq. engineer of Northern Lights
James Bristow Fraser, esq. writer in Edinburgh

William Rae Wilson, esq. of Kelvinbank
Alex. Macdonald, esq. of Dellalay
Robert Bruce, esq. of Symbister, Zetland
William Mowat, esq. younger of Garth, Zetland

29th June 1807.

Right Hon. George, Earl of Galloway
* Right Hon. Robert Walter, Lord Blantyre
Sir James Montgomerie Cunninghame of Corsehill, Bart.
Robert Hay, esq. of Spott
Major-General John Macintyre, of the Honourable East India Company's Service.
James Forbes, esq. of Kingerloch
Alex. Campbell, esq. of Ederline
John Fullerton, esq. of Kilmichael
Thomas Thomson, esq. advocate
John Graham Dalyell, esq. advocate
Norman Hill, esq. of Brownhills, advocate
Daniel Vere, esq. of Stonebyres, advocate
David Falconar, esq. of Carlowrie
Captain James Macalister of Springbank, 13th Dragoons
Claud Russell, esq. accountant, Edinburgh, the Society's Auditor of Accounts
James Hamilton, esq. of Kames, W. S.
James Adam, esq. of Burnfoot, factor on the estate of Seaforth
James Hill, esq. Glasgow
Wm. Braidwood *jun.* esq. Manager of the Marine Insurance Company
John Wardrop, esq. banker, Edinburgh

12th January 1808.

Sir James M. Riddell of Sunart, Bart
Sir William Gordon Cumming Gordon of Altyre and Gordonstone, Bart.
James Vashon, esq Vice-Admiral of the Red
Sir Evan John Murray Macgregor of Lanrick, Bart.
Thomas Knox, esq. son of the Honourable Mr Knox, M. P. for the county of Tyrone
Forbes Hunter Blair, esq. of Dunskey
John Campbell, esq. of Stonefield
James Erskine, esq. of Cambus
Dr Andrew Duncan *jun.* M. D. Edinburgh
Ben. Hawes, esq. of Old Barge Stairs, Blackfriars, London
William Francis Hunter, esq. of Barjarg
Charles Campbell, esq. of Combie
Alex. Brebner, esq. of Learney
Colin Macdougal, esq. of Lunga
Sutherland Mackenzie, esq. Manager of the North British Insurance Company
Colin M'Larty, esq. late of Chestervale, Jamaica, now of Campbelton
Archibald Campbell, esq. of Drumsainy
James Bremner, esq. Solicitor of Stamp Duties
Henry Monteith, esq. of Carstairs, M. P.

27th June 1808.

Right Honourable Gilbert, Earl of Minto
Right Hon. Lord Robert Kerr
* Right. Hon. Lord Gwydyr
Fred. Fotheringham, esq. one of the Commissioners of Excise
Alex. Gordon, esq. late Captain 15th Light Dragoons

Major Colin Mackay, late of the 78th Regiment.
Jn. Farquharson, esq. of Haughton
Lieut.-Col. John Mackintosh of the Royal Marines
Vice-Admiral Sir David Milne, G. C. B.
George Tait, esq. advocate
Captain Alexander Stewart of Strathgary
Chalmers Izet, esq. of Kinnaird
Patrick Neill, esq. Edinburgh
Rev. William Singer, D. D. Minister of Kirkpatrick-juxta

10th January 1809.

* Most Noble George, Marquis of Tweeddale
Gen. the Hon. John Leslie Cumming
Lieut.-Col. the Hon. Charles Cathcart
Hon. Lord Gillies
Robert Stewart, esq. of Alderstone
Henry Home Drummond, esq. of Blair-Drummond, M. P.
John Stewart, esq. of Binny
Rose Campbell, esq.
Hugh M'Lean, esq. younger of Coll
John Mackenzie, esq. late merchant, Leith
James Greig, esq. of Eccles, W. S.
Robert Macmillan, esq. of Polbae, W. S.
William Davidson, esq. younger of Hatton
Sir Samuel Stirling of Glorat, Bart.
William Howieson Crawford, esq. of Crawfordland
John Burnet, esq. of Kemnay
William Ogilvy, esq. younger of Chesters, advocate
John Campbell, esq. of Achawilling
Brigade-Major Howard
Sir Alexander Keith, Knight Marshall of Scotland
Henry Dundas Beatson, esq.
Duncan McKellar, esq. merchant, Glasgow
John Forman, esq. W. S.

26th June 1809.

Dame Ann Preston Campbell of Fernton, Lady Baird
Right Hon. Alex. Lord Elibank
John Harvey, esq. of Ickwell, Bury and Tiningly Park, Yorkshire
Allen Stewart, esq. Bunrannoch
John Stewart, esq. of Shierglass
John Campbell, esq. of Borland
George Lyon, esq. of Ogle
David Blair, esq. of Cookston
Lieut.-Col. George Maxwell, younger of Carruchan
George Robinson, esq. of Clermiston, W. S.
Donald Fletcher, esq of Bernice
Thomas Harkness, esq. of Bailliemore
Wm. Aitchieson, esq. of Drummore
David Thomson, esq. W. S.
George Munro, esq. of Culrain
John Murray, esq. of Conland
John Philips, esq. W. S.
Richard Mackenzie, esq. of Dolphington, W. S.
Francis Wilson, esq. W. S.
John Govan, esq. W. S.
John Macpherson, esq. Chamberlain to Lord Macdonald in Sky
Henry Davidson, esq. Haddington
Geo. M'Andrew, esq. at Torrick
David Mathie, esq. Glasgow

Colin Macnab, esq. Great King Street, Edinburgh
James M'Alpine, esq. merchant, Strachur
Captain William Fraser, residing at Brackla
Alex. Falconer, esq. Nairnside
Capt. John Stewart of the Prince of Wales' Excise Yacht

9th January 1810.

Right. Hon. the Earl of Fingal
Right Hon. James, Lord Ruthven
Archd. Spiers, esq. of Elderslie
Alexander Munro, esq. Princes' Street, Edinburgh
Claud Alexander, esq. of Ballamyle
Wm. Campbell, esq. of Netherplace
William Sommerville, esq. of Sorncastle
Alex. Cooper, esq. of Smithstown
Archibald Campbell, esq. of Catherine Bank
Duncan Campbell, esq. of Barcaldine
Alexander Young, esq. of Harburn, W. S.
Charles Selkrig, esq. accountant, Edinburgh
John Swinton, esq. of Broadmeadows
John M'Culloch, esq. of Barholm
James Murray Grant, esq. of Glenmoriston
Alex. Grant, esq. of Jamaica, Representative in the Hon. House of Assembly for the town and parish of Port Royal
Thomas Rennie Strachan, esq. of Tarrie
Duncan Cowan, esq. merchant, Edinburgh
Alexander Cowan, esq. merchant, Edinburgh
William Dickson Watson, esq.
John Hepburn, esq of Colquhalzie
Major Alexander Macdonald, Royal Horse Artillery
Captain Archibald Campbell of Askomel, Royal Artillery
Anthony Murray, esq. of Crieff
Michael M'Millan, esq. merchant, Glasgow
William Johnstone, esq. of Holmeadow
John Clapperton, esq. of Spyelaw
Æneas Falconer, esq. Blackhills, Nairnshire
And. Bennet, esq. of Muckraw
William Smith, esq. M. P. for Norwich, Honorary Member

2d July 1810.

Sir John Pringle of Stitchell, Bart.
Sir David Maxwell of Cardoness, Bart.
James Urquhart, esq. of Meldrum, Sheriff of Banffshire
George Harley Drummond, esq. of Drumtochty
Robert Barclay Allardice, esq. of Urie
William Cunningham, esq. of Lainshaw
Colonel Archibald Moore, Vice-Lieutenant and Colonel of the Buteshire Local Militia
Lieut.-Col. Alexander Campbell of Posshill, Lanarkshire
Walter Williamson, esq. of Cardrona
Robert Clark, esq. of Comry
David George Sandeman, esq. of Springland, Perthshire
Colin Campbell, esq. merchant, Glasgow
The Rev. G. T. Hamilton, minister of Ashkirk

Captain James Laskey, Galloway Militia
Wm. M'Dowall, esq. of Woolmet

8th Jannary 1811.

Henry David Erskine, esq. of Amondell
James Drummond, esq. M.P. for Perthshire
Colonel Sir Alexander Leith, younger of Freefield
John Gordon, esq. of Cairnbulg
William Calder, esq. merchant, Edinburgh
George Garden Robinson, esq. Banff
Kenneth Francis Mackenzie, esq.
Robert Buchanan, esq. Glasgow
Captain Charles Gregory, 6th Dragoon Guards
Captain Archibald Campbell, Chamberlain to his Grace the Duke of Argyll
James Stewart Robertson, esq. of Edradynate
William Henderson, esq. merchant, Edinburgh
Thomas Megget, esq. W. S.
Lieut.-Col. Alexander Macdonald of the 76th Regiment
Peter Couper, esq. W. S.
Mr John Thomson, bookseller, Edinburgh

1st July 1811.

Right Hon. Charles Lord Linton
The Hon. Col. Hugh Arbuthnot
John Hay, esq. younger of Smithfield and Haystoun, advocate
Murd. M'Laine, esq. of Lochbuy
William Alexander Mackinnon of Mackinnon, esq.
Wm. Sinclair, esq. of Freswick
John Macdonald, esq. of Sanda
Alex. Macduff, esq. of Bonhard
John Harvey, esq. W. S.
John Murray, esq. W. S.

14th January 1812.

The Hon. Baron Clerk Rattray
Sir George Clerk of Pennycuik, Bart. M. P.
Lieut.-General Sir David Baird of Fernton, Bart. G. C. B.
George Sinclair, esq. younger of Ulbster
Gen. Alexander Hay of Rannes
John Dunmore Napier, esq. of Ballockinrain
John Spottiswood, esq. of Spottiswood, solicitor, London
Arthur Nicholson, esq. of Lochend
John Borthwick, esq. younger of Crookston, advocate
Anthony Maxwell, esq. of Cultoquhey
Nicol Allan, esq. Manager of the Hercules Insurance Company
Æneas Macbean, esq. W. S.
James Macdonell, esq. of Milnefield, W. S.
Jas. Wyld, esq. merchant, Leith
James Robertson, esq. ironmonger, Edinburgh
Jas. M'Innes, esq. writer, Edinr.
Thomas Johnston, esq. of Underwood, writer, Edinburgh

29th June 1812.

* Most Noble William, Marquis of Lothian
Sir Alexander Campbell, Bart. of Aberuchill
James Hunter, esq. of Thurston
T. F. Kennedy, esq. of Dunure, M. P.
William Niven, esq. of Achalton and Kirkbride
Hugh Hutcheon, esq. of Southfield
Wm. Hunter, esq. of Ormistown
James Crichton, esq. of Friarscarse
John Donaldson, esq. of Achairne, W. S.

William Harley, esq. of Glasgow
Hector Frederick M'Neil, esq. of Gallochilly
David Stewart Galbreath, esq. of Lochsanish
John Fraser, esq. Cullen House
Robert Morton, esq. jeweller, Edinburgh

12*th January* 1813.

Sir Alexander Ramsay of Balmain, Bart. M. P.
Major-General William Burnet of Banchory Lodge
William Nairne, esq. Assistant Inspector General of Barracks
Patrick Maxwell Stewart, esq. son of Sir M. S. Stewart, Bart.
Sir John Buchan Hepburn of Letham, Bart.
Edward Boyd, esq. of Merton-hall
William Mackintosh, esq. of Millbank
James Carnegy, esq. of Balnamoon
Dugald Campbell, esq. of Kildaloig
Lieut.-Col. David Rattray, 63d Regiment
Major John Grant of Achterblair
Robert Lawson, esq. of Ballimore
Captain Alexander Cumming of Docharn
Dr James Bayne, physician, Inverness
George MacDougall, esq. Edinburgh
Thomas Eddington, esq. merchant, Glasgow
John Mackenzie, esq. writer, Edinburgh
Rev. William Gillespie, minister of Kells
Mr —— Hope, residing at Glenlee
David Louson, esq. town-clerk of Arbroath

28*th June* 1813.

* Right Hon. George Granville, Earl Gower, M. P.
* Right Hon. Archibald, Lord Douglas of Douglas
John Wauchope, esq. of Edmonstone
Alexander Leith, esq. of Freefield
Robert Dalrymple Horne Elphinstone, esq. of Logie-Elphinstone
John Ramsay, esq. of Barra, Aberdeenshire
James Hay, esq. of Monkshill
Walter Bigham Lawrie, esq. of Redcastle
George Scott Elliot, esq. of Larristone
George Reid, esq. of Rathobank
Adam Duff, esq. advocate, Sheriff of Edinburgh
William Horne, esq. of Stircock, advocate, Sheriff of Haddingtonshire
William Macdonald, esq. of Calley-Strathardle, Perthshire
James Grant, esq. of Bucht, Provost of Inverness
Thomas Gilzean, esq. of Bunachton, sometime Provost of Inverness
John Brander, esq. of Pitgavenny
Wm. Young, esq. of Inverugie
Patrick Seller, esq. of Westfield
Andrew Christie, esq. of Ferrybank
Dr Henry M'Laggan, Fellow of the Royal College of Physicians, Edinburgh
George Ramsay, esq. of Inchyre
George Irving, esq. merchant, London

Robert Johnston, esq. merchant, Edinburgh
Right Hon. Alex. Henderson, Lord Provost of Edinburgh
John Reid, esq. merchant, Leith
Charles Oliphant, esq. W. S.
William Bell, esq. W. S.
James Swan, esq. W. S.
John Archibald Campbell, esq. W. S.
James Gordon, esq. of Revack
Alexander Stevenson, esq. soliciter, Edinburgh
Dr Robert Burt, Edinburgh
Major Alexander Mackay of Lagan, Argyllshire
John Fullerton, esq. late of Jamaica
Rev. James Bryce, late minister of Strachan
Mr James Canning, residing at Shiels, Kirkcudbright

11*th January* 1814.

Right Hon. Alexander, Earl of Caithness
Major-Gen. the Hon. Alex. Duff
Sir John Marjoribanks of Lees, Bart. M. P.
Kirkman Finlay, esq. of Castle Toward
Sir Charles Forbes of Edinglassie, Bart. M. P.
Thomas Graham Stirling, esq. of Airth
Major Alexander Francis Taylor, Rothiemay House
Major Robert Macdonald, Royal Horse Artillery
Garden Duff, esq. of Hatton
John Gordon, esq. of Aitkenhead
Wm. Trotter, esq. } merchants in Edin.
Wm. Galloway, esq. } merchants in Edin.
John Mill, esq. } merchants in Edin.
Thos. Allan, esq. banker in Edin.
George Miller, esq. of Frankfield
George Meek, esq. of Campfield
John Learmonth, esq. merchant, Edinburgh
Robert William Hamilton, esq. Edinburgh
Capt. John Cheape, Edinburgh
Major Hugh Macgregor, of the 91st Regiment
Robert Gordon, esq. Croughlie, Banffshire
Robert Wight, esq. accountant, Edinburgh

2*d July* 1814.

The Right Hon. Charles, Lord Colchester, *Honorary Member*
Michael Stewart Nicholson, esq. of Carnock
Ro. Downie, esq. of Appin, M. P.
Angus Mackintosh, esq. of Holm
Thomas Morrison, esq. of Elsick, M. D.
Charles Alexander Moir, esq. of Leckie
James Eddington, esq. of Gargunnock
Lachlan Mackintosh, esq. of Raigmore
William Tait, esq. of Pirn.
Capt. John Boswall Donaldson of Wardie, R. N.
David Dick, esq. of Glensheal
John Carfrae, esq. of Glenboig
Dugald Macdougald, esq. of Gallanich
Wm. Don, esq. banker in Forfar
The Rev. Geo Craig Buchanan of Mackeanston
James Caird, esq. of Drumfad
George Nelson, esq. factor on the estate of Kames, Bute.

10*th January* 1815.

Sir Walter Scott of Abbotsford, Bart.
James Rose, esq. one of the Commissioners of Excise.
Archibald Farquharson, esq. of Finzean, M. P.

William Ramsay, esq. banker, Edinburgh
Robert Jameson, esq. advocate
Dr George Wood, Edinburgh
George Burnet, esq. St Andrew's Square, Edinburgh
John Pitcairn, esq. younger of Pitcairn
John Bowie, esq. of Cambsiscan, solicitor G. P. Office
John Baird, esq. of the Shots Iron-Works
Rev. John M'Kinnon, minister of Slate
Mr John Elder, merchant, Slate
Mr Alexanner Laing, residing at Newton House
Mr William Sibbald, architect, Edinburgh
Mr James Brown, architect, Edinburgh
Mr James Allen, merchant at Grangemouth
Mr Arch. Pollock, merchant at Grangemouth

3d July 1815.

Field-Marshal His Grace Arthur, Duke of Wellington, G. C. B. *Honorary Member*
Most Noble John, Marquis of Bute
Sir Thomas Livingstone of West-quarter, Bart.
Stewart Menzies, esq. of Culdares
Wm. Napier, esq. of Blackstone
Col. David Stewart of Garth
Norman Lockhart, esq. W. S.
James M'Nair, esq. of Glasgow
John Henry, esq. of Corse
Wm. Cochrane, esq. of Ladyland
John Innes Crawford, esq. of Bellfield, Cleghorn-House, Lanarkshire
Duncan Shaw, esq. factor to Clanranald

9th January 1816.

The Hon. Lady Hood Mackenzie of Seaforth
Right Hon. Robert, Lord Belhaven and Stenton
Right Hon. Wm. Adam, Lord Chief Commissioner of the Jury-Court
Admiral the Hon. Sir Alexander Cochrane, G. C. B. of Murdiston, Lanarkshire
Sir James Dalrymple Hay of Park-place, Bart.
James J. Hope Vere, esq. of Craigiehall
John Shaw Stewart, esq. advocate, son of Sir M. Shaw Stewart, Bart.
John Tait, esq. younger of Pirn, W. S.
George Wigham, esq. of Halliday-hill, Dumfries-shire
Dr Francis Buchanan, late of India
Patrick Robertson, esq. advocate
James Saunders Robertson, esq. W. S.
William Fraser, esq. of Glenmead, W. S.
Charles James Fox Orr, esq. of Thornly Park, W. S.
Ro. Kerr, esq. surgeon, Portobello
Capt. Charles Grant, Tombreckachie, Banffshire
Jo. Young, esq. George Street, Edinburgh
Thomas Beveridge, esq. Edinburgh
Donald Mackintosh, esq. writer, Edinburgh
Captain Simon Fraser, Knocky, Inverness-shire

1st July 1816.

Right Hon. Charles Grant, M. P.
Sir Robert Keith Dick of Prestonfield, Bart.

Colonel Sir Colin Campbell, K. C. B.
Rob. Abercromby, esq. younger of Birkenbog and Forglen
Charles Fraser, esq. of Inverallochy and Castle Fraser
Lieut.-Col. Martin Lindsay, 78th Regiment
James Hunt, esq. of Pittencrieff
James Foulis, esq. of Woodhall
Alex. Brodie Campbell, esq. of Forneighty, Hon. East India Company's Service
Watkin Williams Massie, esq. Hon. East India Co's service
William Mackintosh, esq. of Geddes
John S. More, esq. advocate
Thomas Mackenzie, esq. of Inverinnet, W. S.
Robert Campbell, esq. younger of Auchmanoch
Arthur Campbell, esq. W. S.
Hugh Macqueen, esq. W. S.
Donald Mackintosh, esq. W. S.
James Brown, esq. accountant, Edinburgh
Capt. Allan MacCaskill, Hon. East India Co.'s Service
Capt. Gilbert Macdonald, late of the Scots Royals
David Watson, esq. writer, Edinburgh
James Lyon, esq. solicitor, Edin.

14*th January* 1817.

Major-General Sir John H. Dalrymple of Cranstoun and Cousland, Bart.
Sir Charles Macdonald Lockhart of Lee and Carnwarth, Bart.
Richard B. Johnstone Honyman, esq. younger of Armadale
Charles Lennox Cumming Bruce, esq. of Rosile and Kinnaird
Walter Campbell, esq. of Shawfield and Ilay, M. P.
George Forbes, esq. banker in Edinburgh
Alex. Norman Macleod, esq. of Harris
John Campbell, esq. of Saddell
Robert Graham, esq. advocate
Colonel Roderick Macneil of Barra
Robert Maclachlan, esq. of Maclachlan, advocate
James Stewart Hall, esq. late of India
Colonel William Macleod, Hon. East India Co.'s Service
Lieut-Col. Donald Macdonald late 92d Highlanders
Major Archibald Menzies, 42d Regt. or Royal Highlanders
Alexander Fraser, esq. late Lord Provost of Aberdeen
Geo. More Nisbet, esq. of Cairnhill
Andrew Skene, esq. of Lethinty
Geo. Aug. Borthwick, esq. M. D.
Donald Horne, esq. W. S.
Hugh Tod, Esq. W. S.
Robert Sutherland, esq. of St Vincent's
William Macgillewray, esq. of Mocho Plantation, Clarendon, Jamaica
Jo. Stewart, esq. of Fasnacloich
Richard Prentice, esq. solicitor-at-law
Wm. Murray, esq. banker, Tain, factor on the estate of Balnagown
Tho. Fraser, esq. Lieutenant R. N.
James Scott, esq. accountant, Edinburgh
Peter Macdowall, esq. accountant, Edinburgh
Arch. Duncan, esq. writer, Edin.
Donald Stewart, esq. factor on the estate of Harris

30th June 1817.

Sir Wm. Purves Hume Campbell of Marchmont, Bart.
Sir James Wemyss Mackenzie of Scatwell, Bart. M. P.
Capt. Sir Tho. Cochran, R. N.
Colin Campbell, esq. of Strachur
James Wright, esq. of Lawtown
Dr James Hamilton of Corwar
Lieut.-Col. John Campbell, Hon. East India Co.'s Service
Daniel Macdowall, esq. of the Island of St Vincent's
Alex. Gordon, esq. Great King Street, Edinburgh
Samuel Parkes, esq. of Goswell Street, London
James Dunsmure, esq. Secretary to the Herring Fishery Board
Major Dugald Campbell, Royal Artillery
Capt. Donald Macdonald Royal Engineers
Capt. George Robertson, Hon. East India Co.'s Service
Stewart B. Inglis, esq. late King's German Legion
Dugald Gilchrist, esq. of Ospisdale
William Munro, esq. of Achany
Tho. Macmillan, esq. younger of Shorthope, W. S.
George Graham, esq. late of Cassafuar
And. Taylor, esq. of Westbarns
Andrew Bell, esq. late merchant, Leith
Robert Buchan, esq. painter, Edinburgh
Ja. Sands, esq. at Blarcessnock

13th January 1818.

* Right Hon. Thomas, Earl of Elgin and Kincardine
Right Hon. William, Lord Napier
Sir Alex. C. Maitland Gibson of Cliftonhall, Bart.
Lieut.-General James Dunlop of Dunlop, M. P.
William Campbell Hamilton, esq. of Winton
John Corse Scott, esq. of Sinton
William Blair, esq. of Avontoun
John Crawford, esq. of Auchinames
Patrick Grant, esq. of Redcastle
Robert Muirhead, esq. of Croyleckie
Samuel Cooper, esq. of Ballindalloch
John Ure, esq. of Croy Cunningham
Peter Buchanan, esq. of Auchmar
Tho. Gordon, esq. of Buthlaw
Lieut.-Col. W. A. Gordon, late 50th Regt.
Major Malcolm Macleod, late of Bengal
Alex. Chancellor, esq. of Shieldhill
John Morison, esq. W. S.
Mathew N. Macdonald, esq. W. S.
David Greig, esq. W. S.
Walter Campbell, esq. of Sunderland
Capt. Alexander Fraser, Royal Engineers
Capt. Ranald Macdonald, late 92d Highlanders
Captain Charles Macgregor at Delavorar
William Mackenzie, esq. late of Calcutta
Alex. Ponton, esq. of Cairnley
John Mackinlay, esq. of Rothsay
Robert Thom, esq. of the Rothsay Spinning Mills
John Barclay, esq. M. D. Edinburgh
James Saunders, esq. M. D. Edinburgh
Rev. Angus Mackellar, minister of Pencaitland

Alex. Craig, esq. merchant, Edinburgh
John Craig, esq. merchant, Edin.
John Fred. Denovan, esq. Leith
Donald Macintyre, esq. writer, Glasgow

8th July 1818.

General Francis Dundas
Lieut.-Col. John Baillie of Leys
Sir Wm. Baillie of Polkemmet, Bart.
J. R. Smollet, esq. of Bonhill
John Horrocks, esq. of Tilleheun
James Baikie, esq. of Tankerness
Alex. Garthshore Stirling, esq. of Craigbarnet
John Stirling, esq. of Blackgrange
John Bonar, esq. younger of Kimmerghame, banker, Edinburgh
Wm. Macdonald, esq. of Balishare
Alex. Scot, esq. of Trinity-Mains, W. S.
William Waddell, esq. of Easter Moffat, W. S.
James Jardine, esq. civil-engineer
Capt. William Burn Callender of Prestonhall
Donald Stewart, esq. residing at Auch

12th January 1819.

Right Hon. Francis, Lord Elcho
Right Hon. Charles, Lord Strathavon
Right Hon. John, Lord Glenorchy
Right Hon. David, Earl of Airly
Right Hon. Lord Patrick James Herbert Stewart, M. P.
John Arch. Stewart, esq. younger of Grandtully
James Moray, esq. of Abercairney
Wm. Robert Keith Douglas, esq. M. P.
John Campbell, esq. of Blairhall
John Pringle, esq. of Clifton
Alex. Buchanan, esq. of Arnprior
Woodbine Parish, esq. Chairman of the Board of Excise.
Major A. Leith Hay, younger of Rannes
David Anderson Blair, esq. of Inchyra, advocate
J. White Melville, esq. of Mount Melville
Elias Cathcart, esq. younger of Alloway, advocate
John Whitshed Hawkins, esq. of Dunnichen, advocate
Græme Mercer, esq. of Mavisbank
Andrew Hunter, esq. of Holybush, Ayrshire
Robert Bruce, esq. Sheriff-depute of Argyleshire
Robert Davidson, esq. advocate
George F. Mackenzie, esq. of Allangrange
Hugh Fraser, esq. of Eskdale
John Black, esq. of Ardmannoch
Anthony Macdonnell, esq. of Lochgary
Lieut.-Col. John Macdonald of Dalchosnie
John Crawford, esq. late Resident at Java
Robert Granberry Baillie, esq. of Couherallars
John Anderson, esq. of Gladswood
Pat. Sanderson, esq. banker, Edinburgh
Ro. Banks, esq. of Craighead
John Macalister, esq. younger of Straithaird
Ja Gillespie Davidson, esq. W. S.
Humphry Graham, esq. W. S.
James Pedie, esq. W. S.
Robert Mackglashan, esq. of Eastertyre, W. S.

George Robertson, esq. one of the Keepers of the General Records for Scotland
Adam G. Geddes, esq. Paymaster late 10th Garr. Battal.
Capt. Wm. Balfour of Elwick, R. N.
George Mackenzie Ross, esq. of Aldie
Dr Farquhar Mackinnon of Kyle, Skye
Major Allan Macdonald, 55th Regt.
Captain Patrick Campbell of the Royal Navy
Capt. James Macdonald at Culnakyle
Robert Fraser, esq. late of Malta House
Quintin Leitch, esq. Chief Magistrate of Greenock
Robert Taylor, esq. Blackness
William Strang, esq. of Lopness, Orkney
James Dallas, esq. merchant, Edinburgh
Wm. Macbean, esq. Tomatin
Alex. Cameron, esq of Surinam

28*th June* 1819.

Henry S. Wedderburn, esq. of Wedderburn and Birkhill
William Hay, esq. of Drummelzier
George Cranstoun, esq. of Corehouse, Dean of the Faculty of Advocates
John Grant, esq. of Kilgraston
Col. A. Farquharson, 25th Regt. or King's own Borderers
John Stewart, esq. of Bombay
Wm. Mitchell, esq. of Parson's Green, Cashier Royal Bank
Jo. Anderson, esq. of Candacraig
John Wedderburn, esq. Albany, London
Samuel M'Cormick, esq. advocate, Sheriff-depute of Buteshire
Miles A. Fletcher, esq. advocate
Alex. Pearson, esq. W. S.
Ralph J. Dundas, esq. W. S.
Tho. Maconochie, esq. W. S.
Robert Stewart, esq. of Clochfoldich, Dep. Receiver General for Scotland
Alex. Lamont, esq. younger of Knockdow, W. S.
Rob. Speid, esq. of Ardovie, W. S.
John Buchanan, esq. of Carbeath
Neil Mackinnon, esq. of Demerary
Dr Peter Macarthur of Delnies, Nairnshire
William Craig, esq. W. S.
Alex. Johnston, esq. W. S.
Adam M'Chyne, esq. W. S.
Capt. Gilbert Stewart, late 61st Regt., residing at Allean
Capt. Peter Campbell, Hon. East India Co.'s Service
Daniel Fisher, esq. solicitor, Edinburgh
John Macrae, esq. Sheriff-substitute of Ross-shire
Claud Marshall, esq. Sheriff-substitute of Greenock
James Macbraire, esq. of Fishwick-Tweedmouth
John Campbell, esq. Lieut. Royal Navy
William Mackenzie, esq. of the 64th Regt.
Alex. Shepherd, esq. Solicitor, Inverness
James Beaton, esq. do. do.
Gilbert M'Arthur, esq. late of Demeraray.

11th January 1820.

Right Hon. Alexander George Lord Saltoun

Right Hon. Thomas, Earl of Strathmore

Right Hon. Sir Samuel Shepherd, Lord Chief-Baron of the Court of Exchequer

Sir David Moncrieff of Moncrieff, Bart.

Sir Joseph Radcliffe of Millsbridge, Yorkshire

Robert Dundas, esq. of Arniston

Thomas Bruce, esq. of Arnot, one of the Commissioners of Customs for Scotland

Colonel Wm. Henry Knight Erskine of Pittodrie

Wm. Patrick Grant, esq. younger of Rothiemurchus

Arch. Nisbet, esq. of Carphin

Robert Jameson, esq. Professor of Mineralogy and of Natural History in the University of Edinburgh

Roger Ayton, esq. of Murieston, W. S.

Arch. Thomas Fredrick Fraser, esq. of Abertarff

Samuel Anderson, esq. W. S.

Gabriel Reid, esq. of Gordonbush

Major Wm. Clunes of Cracaig

William Dunlop, esq. merchant, Edinburgh

Alex. Henderson, esq. Edin.

Thomas Peat, esq. W. S.

Francis Suther, esq. at Rhives, factor on the estate of Sutherland

Peter Lamond, esq. merchant, Edinburgh

Claud Muirhead, esq. Publisher of the Edinburgh Advertiser

Capt. John Grant of Firhall, Nairnshire

James Anderson, esq. Dep. Clerk of Justiciary

Lieut.-Col. A Mackintosh, Hon. East India Co.'s Service

10th July 1820.

Right Hon. David, Earl of Leven and Melville

Sir William Milliken Napier of Milliken and Napier, Bart.

Tho. Alex. Fraser, esq. of Lovat

Major-General James Stirling

J. H. Maclean, esq. younger of Ardgower, advocate

Capt. James Pringle, Royal Navy, younger of Torwoodlee

Hugh Macdonald, esq. of Bosidale

Rob. Warden, esq. of Parkhill

Henry Ritchie, esq. of Busbie

Wm. Cathcart, esq. of Tower

Wm. Urquhart, esq. of Byth, advocate

James Hay, esq. of Belton

James M'Alpine Leny, esq. of Dalswinton

John Burn Murdoch, esq. of Gartincaber, advocate

Mark Sprott, esq. of Garnkirk, advocate

Rev. Dr John Campbell, Sec. to the Society in Scotland for Propagating Christian Knowledge

Capt. William Ogilvie, R. N.

Capt. Alexander Gordon, R. N.

Wm. Balfour, esq. merchant, Glasgow

Jo. Smart, esq. merchant, Leith

Geo. Hunter, esq. of Callander

James Buchanan, esq. of Buenos Ayres, presently residing at Portobello

Walter Morson, esq. M. D. of the Island of Mountserrat

Capt. Simon Macqueen, residing at Corrybrough

And. Clason, esq. W. S.

Wm. Renny, esq. W. S.

Rob. Stuart, esq. Dep. Presenter of Signatures in Exchequer
Rev. Mr Laurence Moyes, Minister of Forglen
Patrick Cheine, esq. Great King Street, Edinburgh
Capt. Wm. Henderson of Gloup, late 27th Regt.

9th January 1821.

Most Noble James, Marquis of Graham
Right Hon. John William, Earl of Ancram
Right Hon. James, Lord Torphichen
Sir Tho. Dick Lauder of Fountainhall, Bart.
John Lee Allen, esq. of Errol
Lieut.-Col. James Allen of Inchmartin
Charles Ross, esq. of Invercarron, Sheriff-depute of the County of Sutherland
James Mellis Nairne, esq. of Dunsinnan
Wm. Brodie, esq. of Brodie, advocate
John Ayton, esq. of Inchdairney
Jo. Campbell, esq. of South-hall
Robert Graham, esq. M. D. Professor of Botany in the University of Edinburgh
Lieut.-Col. George Scott
Simon Macgillivray, esq. merchant in London
Wm. Grant, esq. younger of Congalton
Angus Macalister, esq. of Balnakeil
Capt. James Stewart of Crossmount
Cha. Stewart, esq. of Shierglass
Jo. Menzies, esq. of Chesthill
Richard Wooley, esq. Wester Dalry
Geo. Cleghorn, esq. of Weens
Alex. Thomson, esq. of Banchory, advocate
Duncan Matheson, esq. advocate
James Fisher, esq. M. D. late Staff-Surgeon to the Army in Canada
Wm. Keith, esq. accountant in Edinburgh
Tho. Ferguson, esq. W. S.
Simon Fraser Mackintosh, esq. W. S.
Jo. Whiteford Mackenzie, esq. W. S.
Jo. Ewing, esq. of Shellagreen, advocate in Aberdeen
Frederick Graham, esq. factor to the Duke of Atholl
Jo. Macfarlane of Muckroy
Capt. Kenneth M'Caskill of Rudunan
Geo. Ballingall, esq. M. D. Professor of Military Surgery in the University of Edinburgh
Tho. Houston, esq. Kintradwell
Alex. Simpson, esq. Helmsdale
Capt. John Mackay, 27th Regt. residing at Farr
Lieut. George Gunn, Half-pay Royal Marines
Alex. Craig, esq. Kirkton
Donald M'Crummen, esq. merchant, Leith
Capt. John M'Crummen, 11th Regt. of Foot
Lieut. J. D. Brown, Markle, East Lothian
Mr Duncan Gibbs, merchant, Inverness
James Smith, esq. Manager of the Deanston Cotton-Works

2d July 1821.

Charles Auguste Count Mercer de Flahault
The Hon. John Gray, eldest Son of Lord Gray

Sir Arch. Edmonstone of Duntreath, Bart.
Wm. Blair of Blair, esq.
Major-Gen. Francis Stewart King of Lesmurdie
James Balfour, esq. of Whittinghame
John Macdougall, esq. younger of Macdougall, Captain Royal Navy
Alex. Pringle, esq. younger of Whitebank
Wm. Traill, esq. of Woodwick, Orkney
Charles Murray Macleod, esq. Harris
Colonel Ja. Mitchell, 92d Regt.
Wm. Curle, esq. of Eastfield.
Alex. Hay Borthwick, esq. of Hopsrig
John Bell, esq. of Dunaby
Thomas Beattie, esq. younger of Crieve
Wm. B. Rose, esq. of Rhynie
Capt. John Macdonell, Killyhonet, Fort-William
Tho. Gillespie, esq. Ardochy
Capt. Donald M'Barnet Ballochroan
Wm. Mitchell, esq. of Gordonhall
Allan Macpherson, esq. Kingussie
James Greig, esq. at Tullich
Wm. Young, esq. W. S.
Tho. Ferguson *jun.* esq. W. S.
William Ellis, esq. Solicitor, Edinburgh
John Anderson, esq. W. S.
Thomas Darling, esq. Solicitor, Edinburgh
Sylvester Reid, esq. W. S. Depute Clerk of Teinds
Peter Brown, esq. at Linkwood, Elgin
Alex. Peterkin, esq. late Sheriff-substitute, Orkney
Robert Flyter, esq. Sheriff-substitute, Fort-William
Peter Falconer, esq. at Craigelachie
John Barker, esq. surgeon, Edinburgh
Wm. Berwick, esq. brewer, do.
Wm. Auld, esq. soap-manufacturer, Leith.

8th January 1822.

Right Hon. James, Viscount Kelburne
Major Augustus Fred. D'Este
Rear-Admiral Sir John P. Beresford, M. P. Commanding the Naval Force in Scotland
John Hay Mackenzie, esq. of Cromarty
Adam Drummond, esq. of Megginch, Captain in the Royal Navy
Arch. Hamilton, esq. younger of Dalzell
Douglas H. Craik, esq. of Arbigland
James Dennistoun, esq. of Colgrain
Lieut.-Col. Wm. Chalmers of Glenericht
Dav. Gordon, esq. of Abergeldie
Alex. Forbes, esq. of Inverernan
Wm. Macpherson, esq. of Blairgowrie
Geo. Mercer, esq. of Gorthy
John Napier, esq. of Mollance
Geo. Traill, esq. younger of Hobbister
James Macdonald, esq. younger of Dalness, advocate
Allan Macpherson, esq. 2. Harley-place, New-road, London
James Davidson, esq. of Colzium
John Lyall, esq. merchant, Edinburgh
Major John Gordon of the 2d or Queen's Regiment of Foot

Major Donald Macdonald of Ardmore
Mathew Weir, esq. W. S.
John Mackean, esq. manager of the Scottish Life Assurance Company
James Stuart, esq. solicitor, Edinburgh
James Macgregor, esq. of Fonab
James Wilson, esq. Sheriff-clerk of the County of Edinburgh
James Aitcheson, esq. St Clement's Wells
John Rennie, esq. younger of Fantassie
John Brodie, esq. of Scoughall
Adam Bogue, esq. of Woodhall
Mr Charles Crawford of East Fortune, East Lothian
Mr Alexander Brodie, Barnie Mains, East Lothian
Mr William Brodie, Upper Keith, East Lothian
Mr Archibald Cuthberson, Peanston, East Lothian
William Russell, esq. advocate
Alexander Smith, esq. of Glenmillan, advocate in Aberdeen
William Galbraith, esq. younger of Blackhouse, Town-clerk of Stirling
John Macinnes, esq. at Dandaleith, Morayshire

1*st July* 1822.

The Right Hon. Lord Francis Leveson Gower, M. P.
John Balfour, esq. of Trenaby, M. P.
Thomas Durham Calderwood, esq. of Polton
Alexander Macintosh, esq. of Macintosh
Alex. Murray, esq. of Broughton
Captain Houston Stewart, R. N.
Harry Leith Lumsden, esq. of Auchindoir
Joseph Murray, esq. younger of Ayton
Donald Macalister, esq. of Loup and Torrisdale, captain Hon. East India Company's service
William Macgillivray, esq. of Bennin Ghadeal
Alexander Henderson, esq. of Warriston
John Bonar, esq. of Ratho
James Hosier, esq. younger of Newlands, advocate
Jas. Loch, esq. barrister-at-law, London
James Veitch, esq. younger of Elliock
Donald Maclean, esq. of Borera
Dugald Maclachlan, esq. of Killimore
John Maclean, esq. of Killunden
Arch. Douglas, esq. advocate
James Ballantyne, esq. younger of Castlehill, advocate
John Marshall, esq. advocate
Alexander Goldie, esq. W. S.
Pat. Wishart, esq. of Lochcoat, W. S.
James Butter, esq. W. S.
Alexander Manners, esq. W. S.
Robert Roy, esq. W. S.
Mr Samuel Morton, agricultural implement maker, Leith Walk
George Johnston, esq. factor to the Earl of Eglinton

14*th January* 1823.

The Hon. William Ogilvy
Sir Wm. Elliot of Stobbs, Bart.
James Wemyss, esq. of Wemyss, M. P. Captain R. N.
Thomas Legh, esq. M. P. Lynn, Cheshire
Ludovick Houston, esq. of Johnston Castle
Major-General John Dalrymple, North Berwick
James Lindsay, esq. younger of Balcarras, Captain, Grenadier Guards
John Boswell, esq. of Kingcausie
Jas. Harvey, esq. of Castlesemple

James Smith, esq. of Jordanhill
William Smith, esq. Lord Provost of Glasgow
The Rev. Peter Legh of Golborne-park, Lancashire
Mark Howard Drummond, esq. of Kelty, major, 72d Regt.
William Foreman Home, esq. of Billie and Paxton
John Traill Urquhart, esq. of Ellsness, Orkney
Wm. Maxwell Alexander, esq. of Mossziel, 22. Upper Grosvenor-street, London
Boyd Alexander, esq. third son of the late Claud Alexander, esq. of Ballamyle
Duncan Campbell, esq. of Ross
John Archibald Murray, esq. advocate
David Scott, esq. of the Bengal Civil Service
Donald Maclean, esq. of Mocho Plantation & Hillside Estate, Jamaica
James Macinroy, esq. of Lude
Francis Walker, esq. of East Fortune
James Stewart, esq. younger of Dunearn
John Richardson, esq. of Pitfour
James Webster, esq. of Balruddery
Patrick Kinnear, esq. younger of Lochton
Charles Hunter, esq. younger of Seaside
Jas. Hunter, esq. of Templehall
Robert Bell, esq. advocate
James Johnston, esq. of Straiton
John J. Henderson, esq. advocate
Hugh Brown, esq. of Broadston, Ayrshire
Geo. Macgachen, esq. advocate
Wm. Taylor, esq. of Troqueerholm
John Stewart, esq. of Dalguise
Robert Stewart, esq. younger of Ardvorlich
Donald Campbell, esq. of Polmont-bank, 12th Lancers
Major P. Dunbar, 3d Regiment, Bengal Cavalry
Captain Ranald Macdonald, 92d Regiment, Military Secretary to the Duke of Manchester, Governor of Jamaica
Wm. Alex. Martin, esq. W. S.
And. Fyfe, esq. M. D. Edinb.
James Dunlop, esq. W. S.
John Pennycuick, esq. younger of Soilerie, Capt. 78th Regt.
James Macallan, esq. W. S.
Alex. Macartney, esq. manager for the Commercial Banking Company of Scotland
Robert W. Niven, esq. W. S.
John Peter Grant, esq. W. S.
Geo. Gosset Hill, esq. merchant in London
Duncan Stewart, esq. writer, Edinburgh
John Young, esq. Glasgow
John Stronach, esq. of Muiryfolds, Banffshire
John Johnston, esq. India-street, Edinburgh
John Fletcher Macfarlane, esq. surgeon, Edinburgh
Alexander Macgrigor *jun.*, esq. writer, Glasgow
Alex. Dudgeon, esq. Humbie
Wm. Henderson, esq. secretary to the British Linen Company
Thos. Jopling, esq. Coldstream
Chas. Robson, esq. of Samieston
Archibald Dunlop, esq. distiller, Haddington
Arch. Dickson, esq. of Huntlaw
Patrick Lindsay, esq. wine-merchant, Leith
John Macfie, esq. merchant, Leith
Andrew Dickson, esq. of Alton

Alex. Anderson, esq. agent for the Bank of Scotland, Inverness

7th July 1823.

Sir James Ramsay of Bamff, Bart.
Sir William Jardine of Applegarth, bart.
Sir J. Scott Douglas of Springwood-park, bart.
Vice-Admiral Sir Philip Henderson Durham of Fordel, G.C.B.
Lieut.-General James Durham of Largo
John Hope, esq. advocate, His Majesty's Solicitor-General for Scotland
George Robertson Scott, esq. of Benholm
Gabriel Hamilton Dundas, esq. of Duddingston
R. Cunningham Bontine, esq. of Ardoch
William Doune Gillon, esq. of Wallhouse
Henry Fletcher Campbell, esq. of Boquhan
Wm. Thomas Carruthers, esq. of Dormont
Wm. Stirling, esq. of Content
Robert Duff, esq. younger of Fetteresso
John Dalzell, esq. of Lingo
William Young Herries, esq. of Spotts
Charles Grant, esq. of Elchies
George Dempster, esq. younger of Skibo
Andrew Bonar, esq. of Kimmerghame
John Macvicar, esq. of Keirfield
Dr Robert Groat of Newhall
Archibald Douglas, esq. younger of Adderstone
William Fraser, esq. younger of Culbockie
Hugh Rose, esq. of Holm
Major J. J. Mackintosh, Madras Artillery, and of Farr, Invernesshire
Captain James Robertson, R.N. Stornaway
C. G. Macgregor Skinner, esq. Lieut. 1st Dragoon Guards
John James Erskine, esq. one of the Members of Council, Prince of Wales's Island
James Hunter, esq. of His Majesty's 70th Regiment
John Graham, esq. younger of Ballagan, advocate
Colin Macrae, esq. of Demarary
Charles Stewart, esq. of Hillside
Rev. Thomas Gibson of Glencrosh, minister of Lochmaben
John Horatio Savigny, esq. Upper Braid
Dr Lachlan Maclean, Tallisker, factor to Sir Hugh Innes of Lochalsh, bart.

13th January 1824.

His Grace John Duke of Bedford
Right Hon. Lord John Hay
The Hon. Wm. Gordon, Capt. R.N. M P. for Aberdeenshire
Vice-Admiral the Hon. Charles Elphinstone Fleming of Biggar and Cumbernauld
The Hon. Colonel John Ramsay of Dysart
The Hon. Jas. Sinclair of Braclangwell
The Hon. John Stuart
Francis Alexander Mackenzie, esq. younger of Gairloch
J. Home Rigg, esq. of Morton and Downfield
James Masterton, esq. of Braco
John James Hope Johnstone, esq. of Annandale
Ewan Baillie, esq. younger of Dochfour

Duncan Davidson, esq. younger of Tullich
Chas. Kinnear, esq. of Kinnear
Patrick Murray Thriepland, esq. younger of Fingask
Francis Balfour, esq. of Fernie
David Gillespie, esq. of Kirkton
John Lennox Kincaid, esq. yr. of Kincaid
Lieut.-Colonel Robert Oswald at Dunnikier
Lieut.-Colonel J. Carruthers of Denby
Nicol Brown, esq. Westerhaughs
John Campbell Colquhoun, esq. of Clathick and Killermont
J. C. Dunlop, esq. Sheriff-depute of Renfrewshire
Lawrence Craigie, esq. Glendoick
Theodore T. Elliot, esq. at Braco Castle, Capt. Engineers, Hon. East India Company's Service
Wm. Gibson Craig, esq. younger of Riccarton
William Loch, esq. of Rachan
John Cross Buchanan, esq. of Auchintoshan
James Campbell, esq. advocate
Kenneth Macleay, esq. Newmore
Lieut.-Col McDowall of Stranraer
John Sinclair, esq. of Barrock
Robert Innes, esq. younger of Thrumster
George Wauchope, esq. George-street, Edinburgh
Major Wm. Neill of Barweill
James Dunlop, esq. of Annanhill
Matthew Culley, esq. of Akeld, Northumberland
Robert Dunmore Napier, esq. of Ballikinrain
Mungo Nutter Campbell, esq. merchant, Glasgow
Thomas Guthrie Wright, esq. auditor of accounts, Court of Session
Alexander Hunter, esq. W. S.
John Lorne Stewart, esq. younger of Glenbuckie
Andrew Thomson, esq. younger of Kinloch, W. S.
John Patullo, esq. of Longhaugh
Carlyle Bell, esq. W. S. one of the Principal Clerks of the city of Edinburgh
James Lamont, esq. Howard-place, Edinburgh
Rev. Francis Laing, rector of Lanmais, Glamorganshire
Patrick Cockburn, esq. accountant, Edinburgh
David Ramsay, esq. W. S.
William H. Playfair, esq. architect, Edinburgh
Major Wm. Henry Horsburgh, Edinburgh
William Burn, esq. architect, Edinburgh
Donald Macqueen, esq. of Corrybrough, Captain 2d Regiment Madras Cavalry
Capt. Allan Maclean, late 36th Regiment
James Cuthbertson, esq. of Seton Mains
James Macdonald, esq. of Flodigarry, Captain Hon. East India Company's service
Alex. Kidd, esq. proc. fiscal of the High Court of Admiralty
And. Mackean, esq. of Locharwoods
Captain James Fullerton, of His Majesty's 30th Regiment
Wm. Wilkie, esq. Ormistonhill
Alex. Hector, esq. writer, Edinb.
Robert Christie, esq. accountant, Edinburgh
Mr John Lyon, governor of Watson's Hospital
Lorne Campbell, esq. factor to the Duke of Argyll, at Roseneath
Stewart Ryrie, esq. of the Commissariat Department

Mr Duncan Stevenson, printer to the University of Edinburgh
Archibald Waldie, esq. agent for the Commercial Banking Company at Kelso
Wm. Deans, esq. at Stewarton
David Cassels, esq. younger of Arnprior
John Allan, esq. of Linkfield
Alex. Duncan, esq. of Glendivine

Number of existing Members in January 1824, *Fourteen Hundred and Sixty-one.*

No. II.

LIST of President, Vice-Presidents, and other Office-bearers, and of the Directors, Ordinary and Extraordinary, for the Year 1824.

PRESIDENT,

His Grace ALEXANDER, DUKE of GORDON, K. T.

VICE-PRESIDENTS.

Right Hon. GEORGE MARQUIS of TWEEDDALE.
Right Hon. THOMAS EARL of ELGIN and KINCARDINE.
Right Hon. P. R. BURREL DRUMMOND, LORD GWYDYR.
Right Hon. Sir JOHN SINCLAIR, Bart.

GILBERT INNES, Esq. of Stow, *Treasurer.*
R. MACDONALD, Esq. of Staffa, *Secretary.*
CLAUD RUSSELL, Esq. Accountant, *Auditor of Accounts*
Messrs LEWIS GORDON and CHARLES GORDON, *Depute-Secretaries and Collectors.*
Mr JAMES MACKAY, *Jeweller and Medalist.*
The Very Reverend GEORGE H. BAIRD, D. D. Principal of the University of Edinburgh, *Chaplain.*

ORDINARY DIRECTORS, according to seniority of Election.

N. B.—Seven Ordinary Directors, senior on the List at the time, go out annually, and a like number are Elected.

1. THOS. ALLAN, esq. of Lauriston, banker, Edinburgh
CLAUD RUSSEL, esq. accountant, Edinburgh
J. GRAHAM DALZELL, esq. advocate
JOSEPH GORDON, esq. of Carrol
CHARLES OLIPHANT, esq. W. S.
ROBERT GRAHAM, esq. advocate
Lieut.-Gen. GRAHAM STIRLING of Duchray and Auchyle
ALEXANDER PRINGLE, esq. of Whitebank
JAMES GRANT, esq. W. S.

10. Col. DAVID STEWART of Garth
JAMES FARQUHAR GORDON, esq. of Locharwoods
ALEX. YOUNG, esq. of Harburn
Sir JOHN HOPE of Craighall, Bart.
JAMES JARDINE, esq. civil engineer
ADAM FERGUSSON, esq. Woodhill
ROBERT PATRICK, esq. of Hazlehead
Dr THOMAS C. HOPE, Professor of Chemistry in the University of Edinburgh
GEORGE MACPHERSON GRANT, esq. of Ballindalloch and Invershie, M. P.
JOHN BARCLAY, M. D. Edinburgh
20. HENRY JARDINE, esq. of Harwood
ROBERT DALRYMPLE HORN ELPHINSTONE, esq. of Logie Elphinstone
DAVID MONRO BINNING, esq. of Softlaw
WILLIAM MACDONALD, esq. of of St Martins
ALEXANDER THOMSON, esq. of Banchory
JAMES HUNTER, esq. of Thurston.
H. HOME DRUMMOND, esq. of Blair Drummond, M. P.
Dr ROBERT GRAHAM, Professor of Botany in the University of Edinburgh
G. ROBERTSON SCOTT, esq. of Benholm
ROBERT DUNDAS, esq. of Arniston
30. ALEXANDER OSBORN, esq. late one of the Commissioners of Customs for Scotland

EXTRAORDINARY DIRECTORS.

1. Right Hon. LORD STRATHAVON
Right Hon. LORD ELCHO
Right Hon. LORD NAPIER
The Hon. WILLIAM MAULE of Panmure, M. P.
The Hon. Colonel FRANCIS W. GRANT of Grant, M. P.
Major-Gen. the Hon. A. DUFF
The Right Hon. Sir SAMUEL SHEPHERD, Lord Chief Baron of the Court of Exchequer
Sir JOHN HAY of Smithfield and Hayston, Bart.
Sir EVAN JOHN MURRAY MACGREGOR of Lanrick, Bart.
10. HENRY MACKENZIE, esq.

END OF VOLUME SIXTH.

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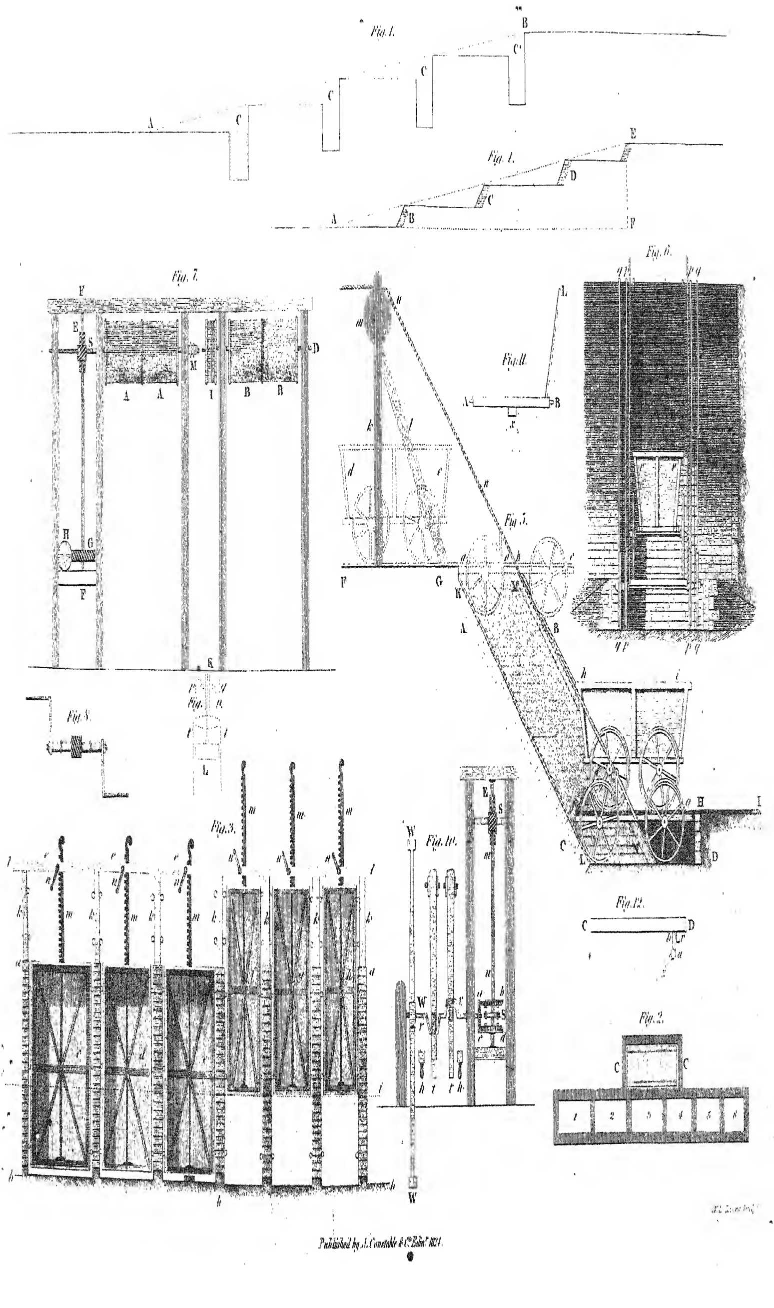

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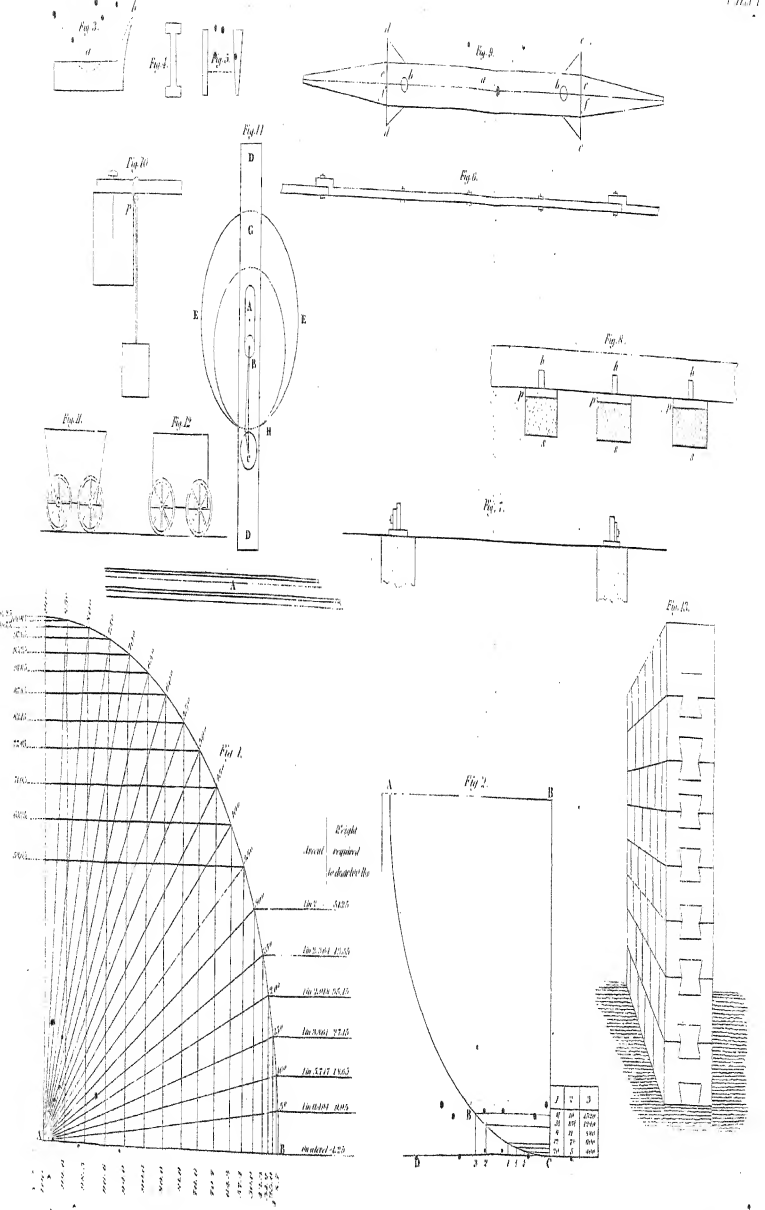

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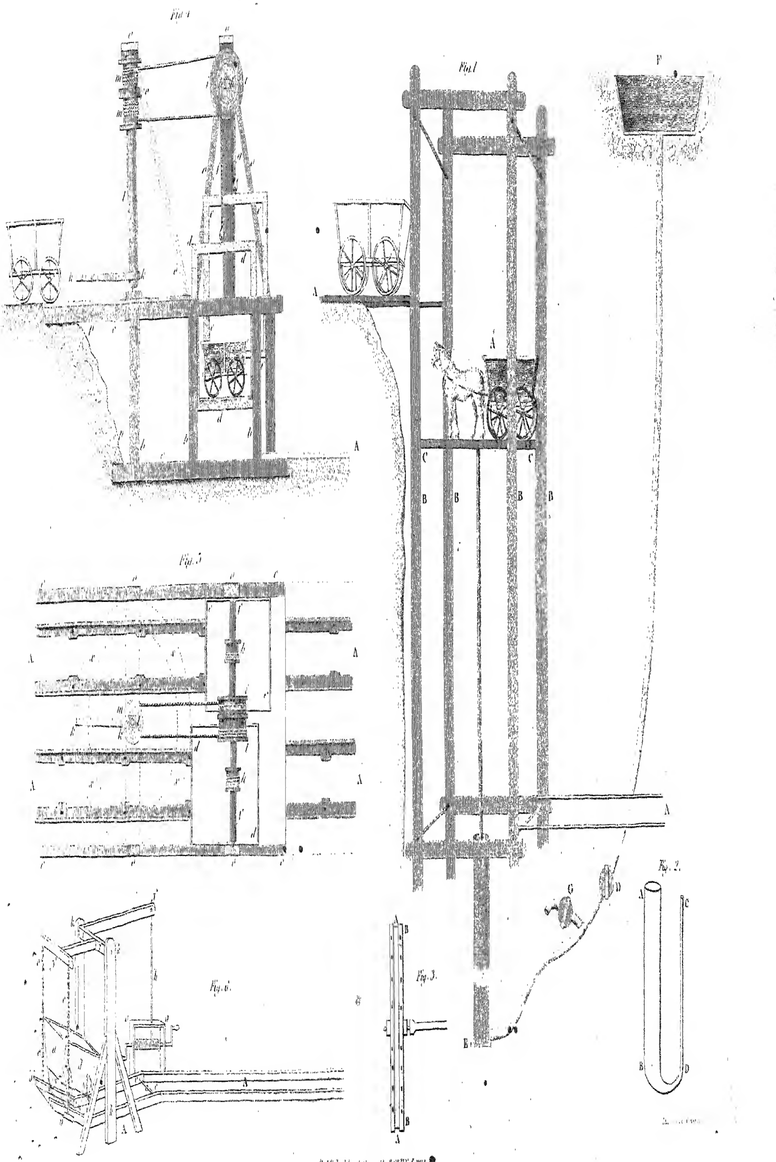

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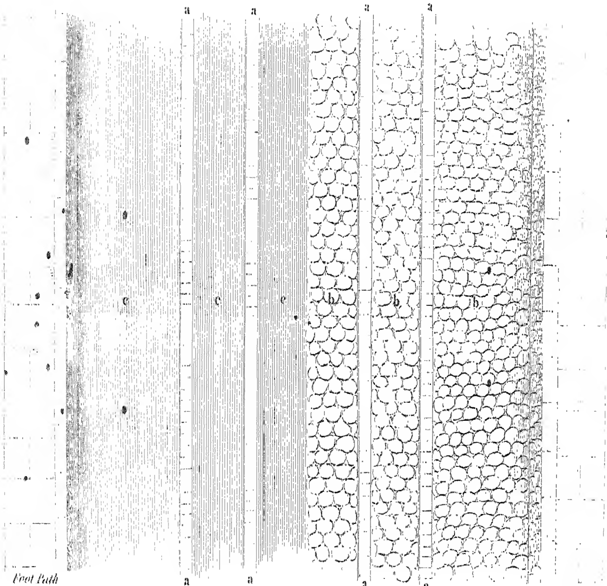
PLATE IV

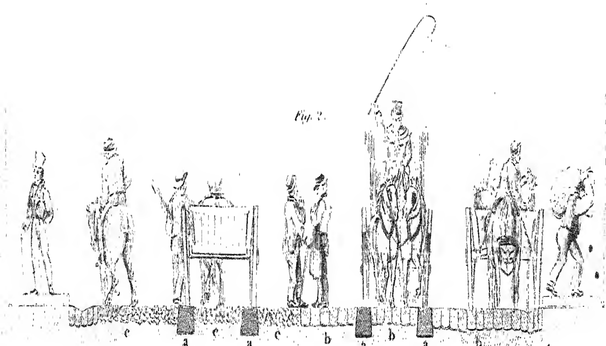
DESIGN FOR A SMOOTH AND DURABLE CITY ROAD

Fig. 1.



PLAN

Fig. 2.



Section with Road Metal between the Tracks *Section with Rubble Causeway between the Tracks*

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SKETCH

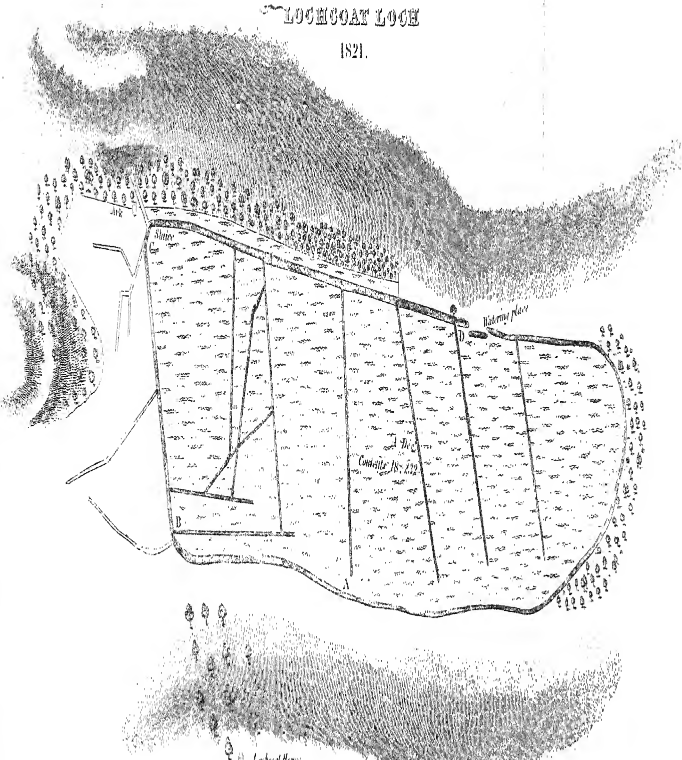
AND MEASUREMENT

OF THE DRAINS

PERFORMED in DRYING

LOCHCOAT LOCH

1821.



The above drains Measure 140 Chains 30 Links or 576 Roods

Explanation

The drains that are coloured red are filled
these coloured blue are open

The open drain from A to B. C & D, was
opened 20 feet wide & 10 feet Deep

The drain from D to A. 9 wide & 6 feet Deep

The Outlet drain to where it enters the Hill,
or cavity in the rock is 40 yards in length
from C to E. built with Stone and Lime
Arched above and flagged below and
varies from 12 to 15 feet Deep.

26th August 1822 Attested by

J Thornton.

W H Lizars sc

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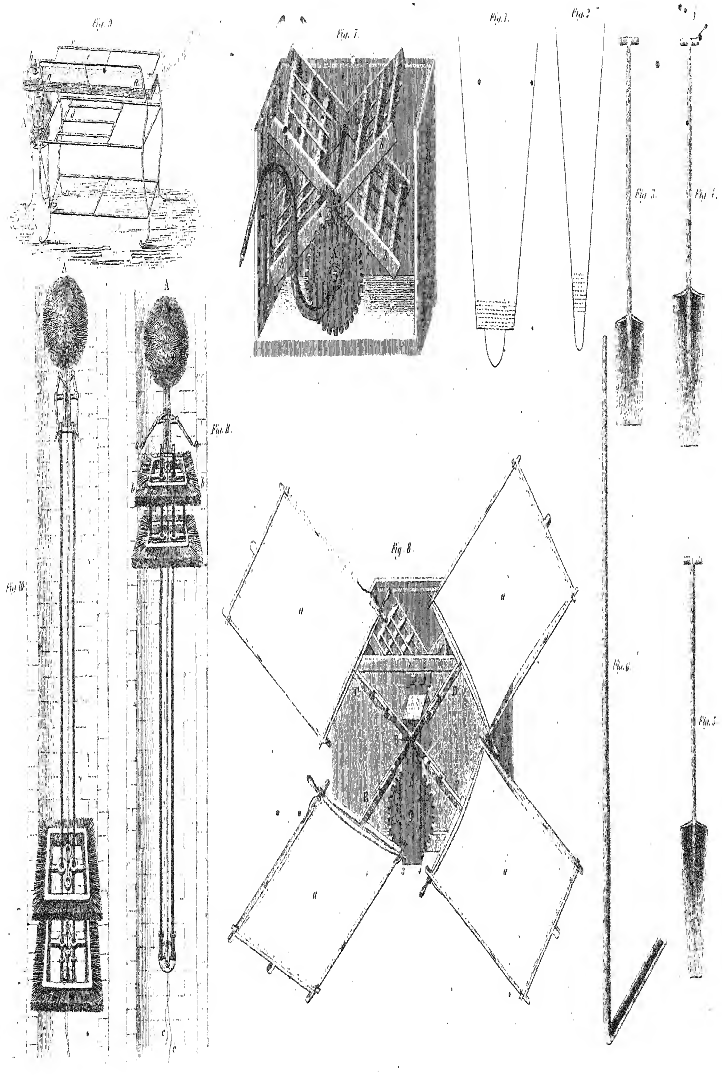
PLATE



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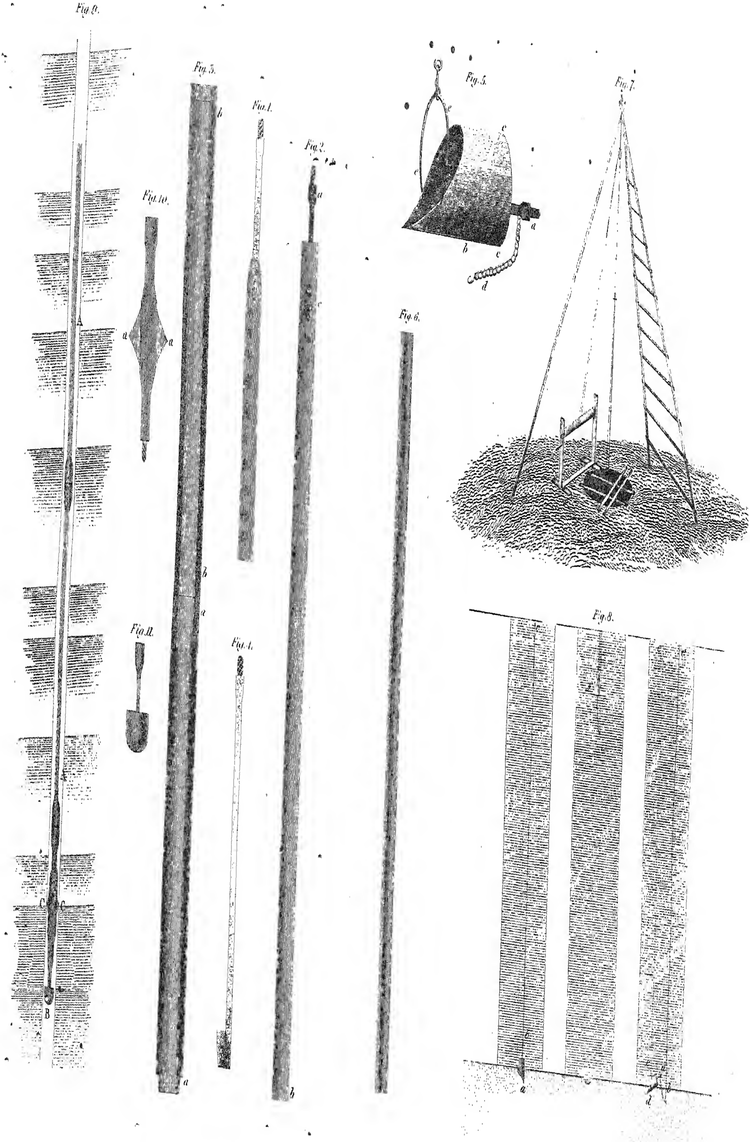

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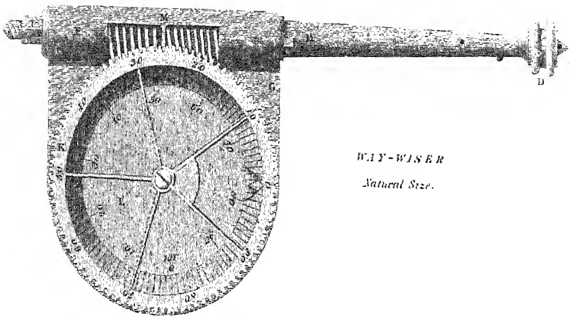
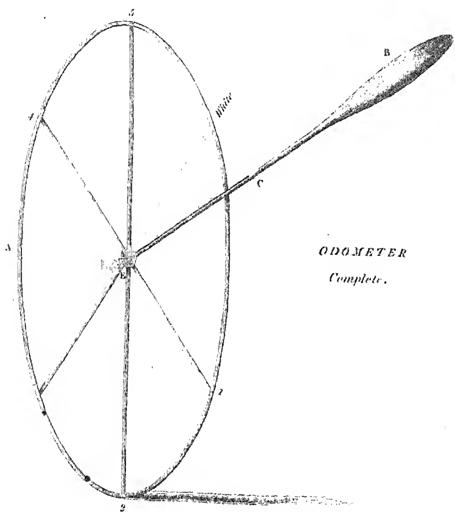


WAY-WISER

Natural Size.



ODOMETER

Complete.

Lizars Sculp^t